



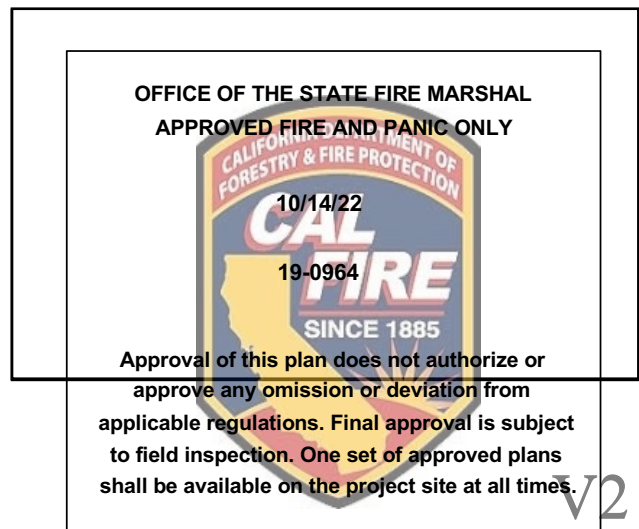
Technical Specifications

County of Humboldt Community Corrections Re-Entry Resource Center

PROJECT NUMBER: 170223
CSFM APPLICATION NO. 19-N-0964-CP-DR



March 2023



VOLUME ONE

INTRODUCTORY INFORMATION

00 01 01	Project Title Page.....	1
00 01 10	Table of Contents.....	6
00 11 16	Invitation to Bid.....	2
00 21 13	Instructions to Bidders	5
00 22 13	Supplementary Instructions to Bidders	2
00 26 00	Procurement Substitution Procedures	2
00 41 00	Bid Form.....	4
00 43 13	Bid Security Form.....	1
00 43 36	Subcontractor List	2
00 45 13	Bidder's Qualifications	3
00 45 19	Noncollusion Affidavit.....	1
00 45 26	Workers' Compensation Certificate	1
00 45 50	Debarment and Suspension Certification	1
00 46 00	Public Contract Code Section 10232 Statement	1
00 52 00	Agreement Forms	3
00 61 13	Construction Performance Bond.....	4
00 61 14	Construction Payment Bond	1
00 63 25	Alternates	1
00 72 00	General Conditions	54
00 73 00	Supplementary General Conditions	1

DIVISION 01 GENERAL REQUIREMENTS

01 11 00	Summary of Work	5
01 30 00	Administrative Requirements	5
01 31 00	Project Management and Coordination	6
01 32 16	Construction Progress Schedule	9
01 33 00	Submittal Procedures.....	4
01 35 00	Modification Procedures	3
01 40 00	Quality Requirements.....	5
01 42 00	References.....	7
01 43 39	Mockups	2
01 50 00	Temporary Facilities and Controls	14
01 55 26	Traffic Controls.....	5
01 56 39	Temporary Tree and Plant Protection.....	4
01 60 00	Product Requirements	10
01 73 00	Execution	6
01 73 29	Cutting & Patching	3
01 74 19	Construction Waste Management and Disposal.....	6
01 77 00	Closeout Procedures.....	9
01 78 39	Project As-Built Documents	5
01 91 13	General Commissioning.....	11

DIVISION 02 EXISTING CONDITIONS

02 30 00	Subsurface Investigation.....	2
02 41 19	Selective Structure Demolition.....	5

DIVISION 03 CONCRETE

03 11 00	Concrete Forming	6
03 15 00	Concrete Accessories	3
03 20 00	Concrete Reinforcing	6
03 30 00	Cast In Place Concrete	26
03 35 00	Concrete Finishing	4
03 35 19	Colored Concrete Finishing	4
03 39 00	Concrete Curing	3

DIVISION 04 MASONRY

04 22 00	Concrete Unit Masonry	14
----------	-----------------------------	----

DIVISION 05 METALS

05 12 00	Structural Steel Framing	9
05 31 00	Steel Decking	6
05 40 00	Cold-Formed Metal Framing	5
05 50 00	Metal Fabrications.....	6
05 51 00	Metal Stairs	5
05 52 16	Metal Egress Barrier Gates.....	3

DIVISION 06 WOOD, PLASTICS AND COMPOSITES

06 20 00	Finish Carpentry.....	2
06 41 00	Architectural Wood Casework.....	8
06 82 00	Pre-Cast Panels	4

DIVISION 07 THERMAL AND MOISTURE PROTECTION

07 13 26	Self-Adhering Sheet Waterproofing	4
07 19 19	Silicone Water Repellents.....	5
07 21 00	Batt Insulation Systems	2
07 26 00	Vapor Retarders.....	2
07 26 50	Vapor Emission Control System	6
07 41 13	Metal Roof Panels.....	6
07 53 00	Elastomeric Membrane Roofing.....	8
07 62 00	Sheet Metal Flashing and Trim	4
07 81 16	Cementitious Fireproofing.....	8
07 92 00	Joint Sealants.....	7
07 95 13	Expansion Joint Cover Assemblies.....	4

DIVISION 08 OPENINGS

08 11 13	Hollow Metal Doors and Frames.....	6
08 14 00	Plastic-Laminate Wood Doors	5
08 31 00	Access Doors and Panels	3
08 33 43	Overhead Coiling Smoke Curtains for Elevator Doors	4
08 41 13	Aluminum Entrances and Storefronts	6
08 56 19	Transaction Windows.....	3
08 56 63	Detention Exterior Window Frames	5
08 62 23	Tubular Skylights.....	5
08 71 00	Door Hardware.....	31
08 81 00	Glass Glazing.....	7
08 88 13	Fire Rated Glazing	5
08 91 19	Fixed Louvers.....	3

DIVISION 09 FINISHES

09 22 16	Non-Structural Metal Framing.....	5
09 29 00	Gypsum Board	11
09 30 00	Tiling.....	7
09 51 13	Acoustical Panel Ceilings.....	5
09 57 13	Security Ceiling Assemblies.....	4
09 65 13	Resilient Base	2
09 67 00	Epoxy Flooring	6
09 68 13	Tile Carpeting.....	5
09 77 10	Fiberglass Reinforced Plastic Panels	2
09 77 26	Resinous Wall and Ceiling Surfacing.....	7
09 84 00	Acoustic Wall Panels.....	3
09 91 00	Painting	6

DIVISION 10 SPECIALTIES

10 11 00	Visual Display Surfaces	2
10 14 00	Signage	6
10 21 13.19	Solid Plastic Shower Partitions and Doors	4
10 26 13	Corner Guards	4
10 28 13	Toilet Accessories.....	3
10 44 00	Fire Protection Specialties	3
10 90 10	TV Monitor Mounts.....	2

DIVISION 11 EQUIPMENT

11 19 00	Detention Equipment Contractor.....	5
11 19 23	Detention Fasteners.....	2
11 40 00	Foodservice Equipment	11
11 66 00	Athletic Equipment	2
11 98 12	Detention Doors and Frames.....	10
11 98 14	Detention Door Hardware	17
11 98 15	Detention Security Glazing	6
11 98 36	Detention Furnishings	6

DIVISION 12 FURNISHINGS

12 21 13	Horizontal Aluminum Blinds	2
12 24 00	Window Shades	3
12 48 00	Exterior Entry Floor Mats	2
12 48 19	Entrance Floor Grating	3
12 93 00	Site Furnishings	2

DIVISION 14 CONVEYING EQUIPMENT

14 24 00	Hydraulic Elevators	14
----------	---------------------------	----

VOLUME TWO

DIVISION 21 FIRE PROTECTION

21 05 00	Common Work Results For Fire Suppression	16
21 10 00	Water-Based Fire-Suppression Systems	15

DIVISION 22 PLUMBING

22 00 50	Basic Plumbing Materials and Methods	26
22 10 00	Plumbing Piping Systems	25
22 40 00	Plumbing Fixtures	8
22 50 00	Plumbing Equipment	7

DIVISION 23 HEATING, VENTILATING AND AIR CONDITIONING

23 00 50	Basic HVAC Materials and Methods	28
23 05 93	Testing, Adjusting, & Balancing For HVAC	17
23 09 00	Direct Digital Control System for HVAC	17
23 10 00	Facility Fuel Systems	11
23 80 00	Heating, Ventilating and Air Conditioning	45

DIVISION 26 ELECTRICAL

26 00 10	Electrical General Provisions	11
26 00 20	Basic Materials & Methods	5
26 05 19	Wires and Cables	4
26 05 26	Grounding	2
26 05 33	Conduit and Fittings	4
26 05 36	Cable Trays	3
26 05 72	Overcurrent Protection	2
26 05 73	Overcurrent Protective Device Coordination	6
26 24 00	Electrical Service and Distribution	3
26 24 16	Panelboards	3
26 27 26	Wiring Devices	2
26 28 16	Disconnects	2
26 28 17	Outlet Boxes	3
26 28 26	Pull & Junction Boxes	1
26 32 13	Diesel Engineered-Driven Generator Sets	13
26 36 00	Automatic Transfer Switches	8

26 50 00 Lighting..... 6

DIVISION 27 COMMUNICATIONS

27 30 00 Telecommunications Copper Distribution 9

DIVISION 28 ELECTRONIC SECURITY AND SAFETY

28 00 00 General Low Voltage Requirements 21
28 05 01 Equipment Enclosures 9
28 05 13 Low Voltage Wire and Cable 3
28 05 20 Low Voltage Devices..... 3
28 05 26 Low Voltage Grounding and Bonding 4
28 05 28 Low Voltage Security Conduit..... 9
28 05 29 Supporting Devices 3
28 05 36 Low Voltage Cable Tray..... 4
28 05 53 Low Voltage Identification 2
28 13 00 Access Control Software and Database Management 19
28 23 00 Video Management System 14
28 31 11 Fire Alarm Systems..... 14
28 46 19 Programmable Logic Control System 10
28 46 23 Touchscreen Control System..... 14
28 46 30 Network Equipment..... 6
28 50 00 Uninterruptible Power System 12
28 51 23 Detention Intercom and Paging 8

DIVISION 31 EARTHWORK

31 09 13 Site Conditions 1
31 09 16 Existing Underground Structures 3
31 10 13 Demolition/Debris Removal 2
31 11 00 Site Clearing and Grubbing..... 3
31 20 00 Earth Moving 10
31 23 15 Shoring and Trench Safety 2
31 23 17 Trenching 3

DIVISION 32 EXTERIOR IMPROVEMENTS

32 11 23 Aggregate Base Courses 2
32 12 16 Asphalt Paving 5
32 13 13 Concrete Paving..... 13
32 16 13 Concrete Curb, Gutter and Sidewalk 4
32 17 23 Pavement Markings 6
32 17 26 Tactile Warning Surfacing..... 4
32 31 19 Decorative Metal Fences and Gates..... 3
32 80 00 Irrigation 7
32 90 00 Planting 6

DIVISION 33 UTILITIES

33 01 32	Sewer and Manhole Testing	6
33 11 16	Site Water Utility Distribution Piping General	6
33 12 16	Water Utilities Distribution Valves	4
33 13 00	Disinfection of Water Utility Distribution	3
33 31 00	Sanitary Utility Sewerage Piping	2
33 41 00	Storm Water Utilities	4

**APPENDIX A – FOUNDATION PLAN REVIEW LETTER AND GEOTECHNICAL ENGINEERING
REPORT**

END OF TABLE OF CONTENTS

NOTICE IS HEREBY GIVEN that sealed bids from the prequalified General Contractors listed below are invited by the Department of Public Works of Humboldt County, a public body, corporate and politic, for the performance of all the work and the furnishing of all the labor, materials, supplies, tools, and equipment for the following project:

**CONSTRUCTION OF
HUMBOLDT COUNTY COMMUNITY CORRECTIONS RE-ENTRY RESOURCE CENTER
COUNTY OF HUMBOLDT
PROJECT NUMBER: 170223**

Pursuant to the Contract Documents on file with the Department of Public Works of Humboldt County.

A pre-bid meeting is scheduled for 2:00 p.m. Pacific Time, **March 07, 2023** at the Humboldt County Jail Administration Office, 901 5th Street, Eureka, California. Contract Documents, Plans and Specifications will be available on **March 1, 2023**.

The following Contractors successfully prequalified through a public prequalification RFQ process released by the County of Humboldt in July of 2022: Arntz Builders, Inc., CA Lic. #856393; Broward Builders, Inc., CA Lic. #602146; Roebbelen Contracting, Inc., CA Lic. #734124; Sletten Construction Company, CA Lic. #446809; Stronghold Engineering, Inc., CA Lic. #787490; S+B James Construction Co., CA Lic. #521929. Bids for this work will only be accepted from the General Building Contractors listed above.

Each Bid must be contained in a sealed envelope addressed as set forth in said Bid Documents, and filed at the office of the Clerk of the Board of Supervisors of Humboldt County, 825 5th Street, Room 111, Eureka, California at or before 2:00 P.M., Pacific Daylight Time, on April 4, 2023. All Bids will be publicly opened and summary amounts read aloud. The officer whose duty it is to open the Bids will decide when the specified time for the opening of Bids has arrived.

Each bid must be in accordance with the bid documents, construction drawings and specifications on file at the Humboldt County Department of Public Works, 1106 Second Street, Eureka, CA 95501. These bid documents, construction drawings and specifications are available for viewing or downloading through the Humboldt County Department of Public Works website at humboldt.gov/bids.aspx. Also through this website, a bidder may view and join a Document Holder's List for this work. Joining the Document Holder's List, and checking to see if there are addenda issued prior to bidding are the sole responsibility of the bidder. If any addendum is issued, the County will attempt to notify each document holder on the Document Holder's List using the email address entered onto the Document Holder's List. County shall not in any way be responsible or liable for failure of a document holder to receive notification. **It is the bidder's responsibility, prior to submitting the bid, to check the website or otherwise inquire to determine whether the County has issued any Addenda.**

Each Bid shall be submitted on the forms furnished by the County within the Bid Documents. All forms must be completed.

Each Bid shall be accompanied by one of the following forms of Bidder's Security to with a certified check or a cashier's check payable to the County, U.S. Government Bonds, or a Bid Bond executed by an admitted insurer authorized to issue surety bonds in the State of California (in the form set forth in said Contract Documents). The Bidder's security shall be in the amount equal to at least ten percent (10%) of the Bid.

The successful Bidder will be required to furnish and pay for a satisfactory faithful performance bond and a satisfactory payment bond in the forms set forth in said Bid Documents.

The County reserves the right to reject any or all Bids or to waive any informalities in any Bid. No Bid shall be withdrawn for a period of one-hundred (100) calendar days subsequent to the opening of Bids without the consent of the County.

All Bidders will be required to certify that they are eligible to submit a Bid on this project and that they are not listed either (1) on the Controller General's List of Ineligible Bidders/Contractors, or (2) on the debarred list of the Labor Commissioner of the State of California.

The successful Bidder shall possess a valid Contractor's license in good standing, with a classification of "B" (General Building Contractor) at the time the contract is awarded.

The successful Bidder will be required to comply with all equal employment opportunity laws and regulations both at the time of award and throughout the duration of the Project.

This project is subject to compliance monitoring and enforcement by the Department of Industrial Relations. Pursuant to Section 1771.1(a) of the California Labor Code, a contractor or subcontractor shall not be qualified to bid on, be listed in a bid proposal, subject to the requirements of Section 4104 of the Public Contract Code, or engage in the performance of any contract for public work, as defined in Sections 1770 et seq. of the Labor Code, unless currently registered and qualified to perform public work pursuant to Section 1725.5 of the Labor Code. It is not a violation of Section 1771.1(a) for an unregistered contractor to submit a bid that is authorized by Section 7029.1 of the Business and Professions Code or by Section 10164 or 20103.5 of the Public Contract Code, provided the contractor is registered to perform public work pursuant to Section 1725.5 at the time the contract is awarded.

The Contractor, and each subcontractor participating in the Project, shall be required to pay the prevailing wages as established by the Department of Industrial Relations, Division of Labor Statistics and Research, P.O. Box 420603, San Francisco, CA, Phone: (415) 703-4780.

The attention of Bidders is directed to the fact that the work proposed herein to be done will be financed in whole or in part with State and County funds, and therefore all of the applicable State and County statutes, rulings and regulations will apply to such work.

In the performance of this contract, the Contractor will not discriminate against any employee or applicant for employment in accordance with the provisions of the California Fair Employment and Housing Act. (Government Code section 12900et seq.)

In accordance with the provisions of Section 22300 of the Public contractors' code, the Contractor may elect to receive 100% of payments due under the contract from time to time, without retention of any portion of the payment, by entering into an Escrow Agreement for Security Deposits In Lieu of Retention.

DATED: _____

ATTEST: _____

By: _____

Kathy Hayes
Clerk of the Board of Supervisors,
County of Humboldt, State of California

END OF SECTION

Sealed Bids will be received by the Clerk of the Board of Supervisors of the County of Humboldt, Humboldt County Courthouse, 825 5th Street, Room 111, Eureka, California 95501, until 2:00 p.m. Pacific Time, on **April 4, 2023** at which time they will be publicly opened by the Clerk of the Board of the County of Humboldt at a public meeting in the Office of the Clerk of the Board, for performance of the following work:

CONSTRUCTION OF
HUMBOLDT COUNTY COMMUNITY CORRECTIONS RE-ENTRY RESOURCE CENTER
PROJECT NUMBER: 170223

1.1 SECURING DOCUMENTS:

Each bid must be in accordance with the bid documents, construction drawings and specifications on file at the Humboldt County Department of Public Works, 1106 Second Street, Eureka, CA 95501. These bid documents, construction drawings and specifications are available for viewing or downloading through the Humboldt County Department of Public Works website at humboldt.gov/bids.aspx. Also through this website, a bidder may view and join a Document Holder's List for this work. Joining the Document Holder's List, and checking to see if there are addenda issued prior to bidding are the sole responsibility of the bidder. If any addendum is issued, the County will attempt to notify each document holder on the Document Holder's List using the email address entered onto the Document Holder's List. County shall not in any way be responsible or liable for failure of a document holder to receive notification. **It is the bidder's responsibility, prior to submitting the bid, to check the website or otherwise inquire to determine whether the County has issued any Addenda.**

1.2 BASIC INFORMATION:

These instructions pertain to the work (as hereinafter defined) to be performed under Agreement with the County of Humboldt (hereinafter sometimes called "Owner"):

Owner Humboldt County Board of Supervisors
825 Fifth Street
Eureka, CA 95501

Owner's Lead Agency: Department of Public Works
County of Humboldt
1106 Second Street
Eureka, CA 95501
Phone: (707) 445-7493
Fax: 445-7409

Project Location: Humboldt County Community Corrections Re-Entry
Resource Center
929 5th Street
Eureka, CA 95501
Humboldt County, CA

Architect: Nichols, Melburg & Rossetto
300 Knollcrest Drive
Redding, California 96002
Phone: (530) 222-3300

- 1.3 RECEIPT OF BIDS:** Each bidder should mark its bid as "Bid for the Construction of Humboldt County Community Corrections Re-Entry Resource Center." Bids shall be deemed to include the written responses to the bidder to any questions or requests for information of County made as part of bid evaluation process after submission of bid. Telephone and telefax proposals will not

be accepted. County will reject all bids received after the specified time and will return such bids to bidders unopened.

1.4 DETERMINATION OF APPARENT LOW BIDDER: Apparent low bid will be based on the amount of the bids listed of the Bid Form with the following criteria:

- A. The apparent low bid will be based on the sum of the Base Bid plus Bid Alternate 1. If no apparent low bid for the Base Bid plus Bid Alternate 1 is less than or equal to \$23,200,000, then proceed to Subsection B below.
- B. The apparent low bid will be based on the Base Bid.

1.5 REQUIRED BID FORM: All bidders must submit bids on the Section 00 41 00, the "Bid Form." County will reject as non-responsive any bid not submitted on the required form. Bids must be full and complete. Bidders must complete all bid items and supply all information required by the bidding documents and specifications. County reserves the right in its sole discretion to reject any bid as non-responsive as a result of any error or omission in the bid. Bidders may not modify the Bid Form or qualify their bids. Bidders must submit clearly and distinctly written bids. Bidders must clearly make any changes in their bids by crossing out original entries, entering new entries and initialing new entries. County reserves the right to reject any bid not clearly written. The Bid Form shall be signed by the bidder's legal representative as indicated on the Bid Form. If the bid is made by an individual, it shall be signed and his/her full name and his/her address shall be given; if it is made by a partnership, it shall be signed with the co-partnership name by a member of the firm, who shall sign his/her own name and provide the name and address of each member; and if it is by a corporation, the bid shall show the name of the corporation and the state under the laws of which the corporation was chartered. When the bid is signed by the duly authorized officer or officers of the corporation, it shall be attested by the corporate seal, and the names and titles of the principal officers of the corporation shall be given. When a bid is signed by an agent, other than the officer or officers of a corporation authorized to sign contracts on its behalf or a member of a partnership, a "Power of Attorney" must be filed with the County prior to opening bids or shall be submitted with the bid; otherwise, the bid may be rejected as irregular and unauthorized. Bids submitted as joint ventures must so state and be signed by each venturer.

1.6 CONTENTS OF BID ENVELOPE: The bid envelope shall contain all of the following:

- A. Section 00 41 00 - Bid Form
- B. Section 00 43 13 - Bid Security Form (Bid Bond)
- C. Section 00 43 36 - Subcontractor List
- D. Section 00 45 13 – Bidder's Qualifications
- E. Section 00 45 19 - Non-collusion Affidavit
- F. Section 00 45 26 - Workers' Compensation Certification
- G. Section 00 45 50 - Debarment and Suspension Certification
- H. Section 00 46 00 - Public Contract Code 10232 Statement

1.7 BID OPENING: The County will stamp bids with the date and time of receipt. Bids will be opened and read publicly at the time and place indicated in Section 1 above. Bidders or their authorized agents may be present. After opening of bids, the County will review all bids for accuracy and reserves the right to correct obvious errors. Upon completion of review, the bids will be ranked by the bid amount as noted in section 1.4 above, and the apparent low bidder will be determined

and notified.

- 1.8 FAILURE TO EXECUTE AND DELIVER DOCUMENTS:** IF the bidder to whom the Contract is awarded shall fail or neglect , with ten (10) calendar days from the date of the receipt of a notice of award, to execute and deliver all required Contract Documents and file all required bonds, insurance certificates and other documents, County may, in its sole discretion, deposit bidder's surety bond, cashier's check or certified check for collection, and retain the proceeds thereof as liquidated damages for bidder's failure to enter into the Contract Documents. Bidder agrees that calculating the damages County may suffer as a result of bidder's failure to execute and deliver all required Contract Documents would be extremely difficult and impractical and that the amount of bidder's required bid security shall be the agreed and presumed amount of County's damages.
- 1.9 BIDDER'S BOND, PERFORMANCE BOND AND PAYMENT BOND:** Bid security must be submitted with the bid. The successful bidder, prior to execution of the Contract, must submit a Performance Bond in the full amount of the Contract. The successful bidder, prior to execution of the Contract, must submit a Payment Bond in the full amount of the Contract.
- A. The company providing the required performance and payment bonds must be listed in U.S. Treasury Circular No. 570 as a surety approved to issue bonds securing Government contracts in the State of California
- 1.10 REQUIRED LISTING OF PROPOSED SUBCONTRACTORS:** Each bid shall have listed therein the name, address, description of work, contractor's license number and DIR Registration Number of each subcontractor to whom the bidder proposes to subcontract portions of the work in the amount of 1/2 of one percent of their total bid, in accordance with the Subletting and Subcontracting Fair Practices Act, commencing with Section 4100 of the Public Contract Code and for verification of conformance with Labor Code Sections 1771 and 1725.5. The bidder's attention is invited to other provisions of said Act related to the imposition of penalties for a failure to observe its provisions by using unauthorized subcontractors or by making unauthorized substitutions.
- A. A sheet for listing the subcontractors, as required herein, is included in the specifications. Please reference Section 00 43 36 "Subcontractor List."
- 1.11 INSURANCE:** It is highly recommended that bidders confer with their respective insurance carriers or brokers to determine in advance of bid submission the availability of the insurance certificates and endorsements required. A bidder, who executes the Contract and thereafter fails to comply strictly with the insurance requirements, will be deemed to be in breach of Contract.
- 1.12 RESERVATION OF RIGHTS:** County specifically reserves the right, in its sole discretion, to reject any or all bids, or re-bid, or to waive minor irregularities from bid requirements. If no bids are received, the County reserves the right to identify interested contractor(s) and negotiate directly without re-bidding.
- 1.13 SECURITIES IN LIEU OF RETENTION:** Public Contract Code Section 22300 gives the Contractor for option to deposit securities with an escrow agent as a substitute for retention earnings to be withheld by the County.
- 1.14 PRE-BID MEETING:** The Pre-Bid Meeting is scheduled for 2:00 p.m. Pacific Time, March 7, 2023 at the Humboldt County Correctional Facility, Administration Briefing Room, 901 5th Street, Eureka California.
- 1.15 WITHDRAWAL OF BIDS:** Any bidder may withdraw his/her bid, either personally or by written request, any time prior to the scheduled closing time for receipt of bids.

1.16 QUESTIONS AND CLARIFICATIONS: In order to avoid any misinterpretation or misrepresentation between the Bidder, the Architect and the County as regards the plans and specifications for the Project, neither the County nor Architect will respond to any verbal or telephone inquiries, however Bidders may submit written inquiries for clarifications or questions by email or mail to the attention of Department of Public Works, 1106 Second Street, Eureka, CA 95501,, Email: capitalprojects@co.humboldt.ca.us . Any responses to written Bidder inquiries will be at the full discretion of the County, and any responses will be in writing in the form of an Addendum to these Contract Documents, which will be sent to all Bidders.

1.17 MINIMUM RATES OF PAY: Contractor, and each subcontractor participating in the Project, shall be required to pay the prevailing wages as established by the Department of Industrial Relations, Division of Labor Statistics and Research, P.O. Box 420603, San Francisco, CA, Phone: (415) 703-4780. A schedule of the minimum rates of pay applicable to this Contract may be determined through the Department of Industrial Relations website at: <https://www.dir.ca.gov/OPRL/DPreWageDetermination.htm> or is on file at the principal office of Humboldt County Public Works at 1106 Second Street, Eureka, California, and shall be made available to any interested party on request.

1.18 COMMUNICATIONS:

- A. All notices, demands, requests, instructions, approvals, proposals, and claims must be in writing.
- B. Any notice to or demand upon the Contractor shall be sufficiently given if delivered at the office of the Contractor stated on the signature page of the Contract or at such other office as Contractor may from time to time designate in writing to the County of Humboldt or deposited in the United States mail in a sealed postage-prepaid envelope, or if delivered with charges prepaid to any delivery company for transmission, in each case addressed to such office.
- C. All papers required to be delivered to the County shall, unless otherwise specified in writing to the Contractor, be delivered to the County and any notice to or demand upon the County of Humboldt shall be mailed in a sealed, postage-prepaid envelope, or delivered with charges prepaid to any delivery company for transmission to the County of Humboldt at such address, or to such other representatives of the County of Humboldt or to such other address as the County may subsequently specify in writing to the Contractor for such purpose.
- D. Any such notice shall be deemed to have been given as of the time of actual delivery; or, in the case of mailing, when the same should have been received in due course of post; or, in case of any delivery company, at the time of actual receipt.

1.19 SUBSTITUTIONS:

- A. All pre-bid procurement substitution requests for "equal" products or systems shall be submitted to the Owners Representative 10 days prior to the contract bid opening date. All pre-bid substitution requests shall be submitted on the procurement substitution form, see Section 00 26 00.
- B. Product substitution requests for products that are "equal" to specified products but not produced by an "Acceptable Manufacturer", per each technical specification shall be submitted within 35 days after the contract is awarded. All product substitution requests shall be submitted on the PRODUCT SUBSTITUTION REQUEST FORM; see Section 01 60 00, "Product Requirements."

1.20 ADDENDA OR BULLETINS: Any Addenda or Bulletins issued during the time of bidding or forming a part of the Documents loaned to the Bidder, for the preparation of his Bid, shall be covered in the Bid, and shall be made a part of the Contract.

1.21 BIDDERS INTERESTED IN MORE THAN ONE BID: No person, firm, or corporation shall be allowed to make or file, or be interested in more than one bid for the same work, unless alternate bids are called for. A person, firm, or corporation, who has submitted a sub-proposal to a bidder,

is not thereby disqualified from submitting a sub-proposal or quoting prices to the other bidders.

- 1.22 VISITING THE SITE & KNOWLEDGE OF PLANS & SPECIFICATIONS:** Before submitting a bid for the work, it is recommended that the Bidder inspect the sites and inform himself as to the conditions under which he will be obligated to execute the work. A Pre-Bid meeting and walk-through are scheduled for this project. See Paragraph 1.13 above.

No allowance will be subsequently made for failure to inspect, and the Bidder will be solely responsible for the consequences of his negligence or lack of diligence. Before submitting any proposal, each Bidder shall examine the General Conditions, Plans, Specifications, as well as these Instructions to Bidders, and the forms appended hereto and made a part hereof.

- 1.23 BID PROTEST:** Any bid protest must be in writing and must be received by the Director of Public Works, Humboldt County Department of Public Works, 1106 Second Street, Eureka, CA, 95501, Fax: (707) 445-7409 or by email before 5:00 p.m. no later than three (3) working days following bid opening (the "Bid Protest Deadline") and must comply with the following requirements:
- A. Only a bidder who has actually submitted a Bid Proposal is eligible to submit a bid protest against another bidder. Subcontractors are not eligible to submit bid protests. A bidder may not rely on the bid protest submitted by another bidder, but must timely pursue its own protest.
 - B. The bid protest must contain a complete statement of the basis for the protest and all supporting documentation. Material submitted after the Bid Protest Deadline will not be considered. The protest must refer to the specific portion or portions of the Contract Documents upon which the protest is based. The protest must include the name, address and telephone number of the person representing the protesting bidder if different from the protesting bidder.
 - C. A copy of the protest and all supporting documents must also be transmitted by fax or by e-mail, by or before the Bid Protest Deadline, to the protested bidder and any other bidder who has a reasonable prospect of receiving an award depending upon the outcome of the protest.
 - D. The protested bidder may submit a written response to the protest, provided the response is received by the Department Director before 5:00 p.m., within two (2) working days after the Bid Protest Deadline or after receipt of the bid protest, whichever is sooner (the "Response Deadline"). The response must include all supporting documentation. Material submitted after the Response Deadline will not be considered. The response must include the name, address and telephone number of the person representing the protested bidder if different from the protested bidder.
 - E. The procedure and time limits set forth in this section are mandatory and are the bidder's sole and exclusive remedy in the event of bid protest. The bidder's failure to comply with these procedures shall constitute a waiver of any right to further pursue a bid protest, including filing a Government Code Claim or initiation of legal proceedings.

END OF SECTION

1. PROJECT DESCRIPTION

Construction of Humboldt County Community Corrections Re-Entry Resource Center.

- A. Project Location:
Humboldt County Community Corrections Re-Entry Resource Center
929 5th Street
Eureka, CA 95501

2. TIME FOR COMPLETION

The Contractor shall complete the entire project within **540** calendar days from the County's issuance of the "Notice to Proceed".

3. LIQUIDATED DAMAGES

It is understood and agreed that in case all of said work is not complete within the Agreement time, damages will be sustained by the Owner, and that it is and will be impractical or extremely difficult to determine the actual damages which the Owner will sustain in the event and by reason of such delay; and it is therefore agreed that the Contractor will pay to the Owner the sum of three thousand five hundred dollars (\$3,500) per day for each and every day's delay beyond the Agreement time specified as liquidated damages and in case the same are not paid, agrees that the Owner may deduct the amount therefrom any money due or that may become due the Contractor under this contract.

4. JOB OFFICES

- A. The Contractor must designate an area to serve the posting requirements of this contract. A board (4' x 8') must be in plain view in a well-trafficked area on site. On this board will be posted EEO and wage information in compliance with the General Conditions of this contract.
- B. The Contractor and their subcontractors may maintain such office and storage facilities on the site as may be necessary for the proper conduct of the work. These shall be located so as to cause no interference with any work to be performed on the site. The Owner's Representative shall be consulted with regard to locations.
- C. Upon completion of the project, or as directed by the County of Humboldt, Owner's Representative, the Contractor shall remove all such temporary structures and facilities from the site, same to become their property, and leave the premises in the condition required by the County.
- D. The Contractor shall furnish and maintain, during construction of the project, adequate facilities at the site to be designated by the County of Humboldt for the use of the County of Humboldt and the Architect. Refer to Section 01 50 00.

5. NOISE ABATEMENT PROVISIONS

- A. Noise Affecting Sites and Adjacent Neighborhoods:
1. Limit noise and vibration to a reasonable level as related to specific items of equipment used and their hours of use and as indicated herein. This does not preclude use of mechanical equipment, i.e. jack hammers or power driven fasteners.
 2. Comply with all local noise ordinances.
 3. The Owner's Representative and the Owner shall be the sole judges of permissible noise and vibration levels and they have the right to designate times when they may be used. Comply also with requirements of Section 01 11 00 – Summary Of Work.

- B. External Noise:
 - 1. Locate stationary noise sources away from noise sensitive land uses and buildings to the extent possible. Obtain approval from the Owner's Representative before locating stationary noise sources.
 - 2. Use truck haul routes through surrounding communities which minimize impacts on noise sensitive land uses. On the site, use routes as directed and approved by Owner's Representative.
- C. Vibration Control: Provide ten (10) working days notice before conducting construction activities that might cause vibration, such as, but not limited to, drilling, excavation, compaction, pile driving, etc.
- D. Noise Levels: Do not exceed an average continuous sound level of 72 dBA, measured at the perimeter of the work area, and do not exceed an impact noise level of 100 dBA measured at the perimeter of the work area, and only two impact occurrences between 72 dBA and 100 dBA are permitted in a one-hour period.

END OF SECTION

Project Name: Community Corrections Re-Entry Resource Center **Date:** _____

Project Number: 170223

Note to Contractor: All pre-bid substitution requests for "equal" products or systems shall be submitted to the Owner's Representative, ten (10) days prior to the contract bid date. Refer to specification Section 00 21 13 INSTRUCTIONS TO BIDDERS, section 1.19 "Substitutions." See Section 01 60 00 "PRODUCT REQUIREMENTS" for substitution request during construction.

We hereby submit for your consideration the following product in lieu of the specified item for the above project.

SECTION: _____ Paragraph: _____

Specified Item: _____

Proposed Substitution: _____

1. Attach completed technical data, including laboratory tests, color and material samples, if applicable
2. Include complete information on changes to Drawings and/or Specifications which proposed substitution will require for its proper installation. (Plan layout changes, electrical hookup locations)
3. Does the substitution affect dimensions shown on Drawings? Yes No
4. Will the undersigned pay for changes to the building design, including detailing costs caused by the requested substitution? Yes No
5. What effect does substitution have on other trades?
6. Differences between proposed substitution and specified item?
7. Cost of proposed substitution in comparison with product, system, or method specified?
8. Availability of maintenance and repair services, and sources of repair or replacement items?
9. Manufacturer's guarantees of the proposed and specified items are:
 Same Different (Explain on attachment)

The undersigned states that the function, appearance and quality are equivalent or superior to the specified item.

Submitted By: _____

Signature: _____

Firm: _____

Address: _____

Telephone: _____

FOR USE BY ARCHITECT:

Accepted Accepted as Noted_

Not Accepted Received Too Late_

By: Date:

Remarks:

END OF SECTION

TO
THE COUNTY OF HUMBOLDT for the CONSTRUCTION of
HUMBOLDT COUNTY COMMUNITY CORRECTIONS RE-ENTRY RESOURCE CENTER
CONTRACT NUMBER 170223

Name of Bidder: _____
(Note: Name must be exactly as it appears on Contractor's License.)

Business Address: _____

Telephone Number: _____

Residence Address: _____

The work to be done shall be constructed in accordance with the Contract Documents, prepared by NMR + Lionakis Architects, Dated _____, the Agreement annexed hereto and the General Prevailing Wage provisions as specified in the "Invitation to Bid".

Bids are submitted for the entire work. The amount of "The Bid" for comparison purposes will be the determination of the apparent low bid as specified in Section 00 21 13, "Instructions to Bidders".

The Bidder shall set forth for the Base Bid and each Alternate, if any, in clearly legible figures, a written lump sum price and a numeric lump sum price.

In case of a discrepancy between the two notated prices, the written price shall prevail, unless, however, if the amount set forth in writing is ambiguous, unintelligible or uncertain for any cause, or is omitted, then the amount set forth in the numeric column for the item shall prevail.

If this proposal shall be accepted and the undersigned shall fail to enter into the Contract and to give the two required bonds in the sums to be determined as aforesaid, with surety satisfactory to the Department of Public Works, within seven (7) days, not including Sundays and legal Holidays, after the Bidder has received notice from the Department that the contract has been awarded, the County may, at its option, determine that the Bidder has abandoned the Contract, and thereupon this Proposal and the acceptance thereof shall be null and void and the forfeiture of such security accompanying this Proposal shall operate and the same shall be the property of the County of Humboldt.

The undersigned, as Bidder, declares that the only persons or parties interested in this proposal as principals are those named herein; that this proposal is made without collusion with any other person, firm, or corporation; that Bidder has carefully examined the location of the proposed work, the annexed proposed form of contract, and the plans therein referred to; and proposes and agrees if this proposal is accepted, that Bidder will contract with the County of Humboldt, in the form of the copy of the contract annexed hereto, to provide all necessary machinery, tools, apparatus and other means of construction, and to do all the work and furnish all the material specified in the contract, in the manner and time therein prescribed, and according to the requirements of the Architect as therein set forth, and that he will take in full payment therefor the following item prices to wit:

Receipt and compliance with the following Addenda to the Contract Documents is acknowledged:

Addendum No. _____ Dated _____

Addendum No. _____ Dated _____

Addendum No. _____ Dated _____

Addendum No. _____ Dated _____

Addendum No. _____ Dated _____

I, _____ as an agent for _____
_____ declare under penalty of perjury under the laws of the
State of California, that the information contained in this Bid is true and correct.

Executed at _____, California, on _____, 20____

The project shall be complete within the time limits specified in Section 00 01 10, "Special Conditions."
The undersigned is aware the Contract includes provisions for liquidated damages as specified in Section
00 01 10, "Special Conditions," if the Project is not completed within the agreed time of completion.

THE UNDERSIGNED, as Bidder, proposes the following:

BASE BID:

To furnish and complete the entire work as shown on the drawings and listed in the specifications,
including required contract bonds and insurance, without additions or subtractions on account of specified
alternates, for the sum of:

Base Bid (Lump Sum):	
_____	\$ _____
Total Amount in Words	Total

BID ALTERNATES:

Additive Alternate No. 1 (Lump Sum):	
_____	\$ _____
Total Amount in Words	Total

UNIT PRICES

For changing quantities of work items from those indicated on the contract drawings and specifications, upon written instructions from the Architect, the following prices shall prevail:

1. Overexcavation and replacement with engineered fill due to loose, soft, or unsuitable soil materials at a unit cost PER CUBIC YARD: \$ _____

The above unit prices shall include all labor, materials, bailing, shoring, removal, overhead, profit, insurance etc., to cover the finished work of the several kinds called for. Changes shall be processed in accordance with the General Conditions and may be additive or deductive.

Proposal Signature Page

Accompanying this proposal is _____
(Insert the words "Cash (\$)", "Cashier's Check", "Certified Check", or "Bidder's Bond", as the case may be) in the amount of at least ten percent (10%) of the total Bid Price submitted. The names of all persons interested in the foregoing proposal as Principals are as follows:

(NOTE: If a Bidder or other interested person is a Corporation, state the legal name of the corporation, also names of the president, secretary, treasurer, and manager thereof; if a Co-partnership, state the true name of the firm, also state the names of all individual co-partners composing the firm; if the Bidder or other interested person is an Individual, state the first and last names in full.)

Licensed in accordance with an Act providing for the registration of Contractors:

License No.: _____ Expiration Date: _____

By my signature on this proposal I certify, under penalty of perjury under the laws of the State of California, that the foregoing questionnaire and statements of Public Contract Code Section 10162, and 10232, are true and correct and that the bidder has complied with the requirements of Section 8102 of the Fair Employment and Housing Commission Regulations (Chapter 5, Title 2 of the California Administrative Code). By my signature on this proposal I further certify, under penalty of perjury under the laws of the State of California and the United States of America, that the Noncollusion Affidavit required by Title 23 United States Code, Section 112 and Public Contract Code Section 7106; and the Title 49 Code of Federal Regulation, Part 29 Debarment and Suspension Certification are true and correct.

Signature of Bidder Date

If a Bidder is a Corporation or a Co-partnership:

Name of Corporation or Firm Name of Co-Partnership

Signatures of officer(s) or partners authorized to sign contracts on behalf of the Corporation or Co-partnership, Corporations require signature by 2 (two) corporate officers:

Name Title

Name Title

Name Title

If Signature is by an agent, other than an officer of a corporation or a member of a partnership, a Power of Attorney must be on file with the Department prior to opening Bids or may be submitted with the Bid; otherwise the Bid will be disregarded as irregular and unauthorized.

Bidder's Business Address: _____

Place of Residence: _____

Date: _____

END OF SECTION

KNOW ALL MEN BY THESE PRESENTS:

That _____ as Principal and _____ a corporation, organized and existing under and by virtue of the laws of the State of _____ and authorized to do surety business in the State of California, as Surety, are held and firmly bound unto the County of Humboldt, State of California, as Obligee, in the sum of _____, Dollars (\$ _____), for the payment of which sum well and truly to be made, we, and each of us, bind ourselves, our heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents.

THE CONDITION OF THIS OBLIGATION IS SUCH that whereas the Principal has submitted a bid to the County of Humboldt, State of California, for all work specifically described in the accompanying bid;

NOW, THEREFORE, if the aforesaid Principal is awarded the contract, and within the time and manner required under the specifications, after the prescribed forms are presented to Principal for signature, enters into a written contract in the prescribed form, in accordance with the bid, and files the two bonds, one guaranteeing faithful performance and the other guaranteeing payment for labor and materials as required by law, or if the said Principal shall fully reimburse and save harmless the Obligee from any damage sustained by the Obligee through failure of the Principal to enter into the written contract and to file the required performance and labor and material bonds, then this obligation shall be null and void; otherwise, it shall be and remain in full force and effect.

In the event suit is brought upon this bond by the Obligee and judgment is recovered, the Surety shall pay all costs incurred by the Obligee in such suit, including a reasonable attorney's fee to be fixed by the Court.

IN WITNESS WHEREOF, we have hereunto set our hands and seals this _____ day
of _____, 20 _____.

By: _____
Principal (Seal) Surety (Seal)

- NOTE: (1) Signature of those executing for the surety must be properly acknowledged.
(2) This bond must be in an amount equal to as least ten (10%) percent of the amount bid.
(3) Bidders must use this form unless the surety company form is substantially the same.

END OF SECTION

LIST OF SUBCONTRACTORS

Project Name: HUMBOLDT COUNTY COMMUNITY CORRECTION RE-ENTRY RESOURCE CENTER
PROJECT NUMBER: 170223

Prequalified Security Electronics Integrator must be a listed Sub-Contractor:

<u>Kind of Work</u>	<u>Name</u>	<u>Location (City)</u>	<u>CSLB License No.</u>	<u>DIR Registration No.</u>
Security Electronics Integrator				

The Bidder shall list all Subcontractors in accordance with Article 47 of the General Conditions:

<u>Kind of Work</u>	<u>Name</u>	<u>Location (City)</u>	<u>CSLB License No.</u>	<u>DIR Registration No.</u>

1.1 DETERMINATION OF BIDDER RESPONSIBILITY

- A. A responsible bidder is a bidder who has demonstrated the attribute of trustworthiness, as well as quality, fitness, capacity and experience to satisfactorily perform the contract. It is the County's policy to conduct business only with responsible contractors. (Ord. 2291, § 1, 01/07/2003)
- B. Bidders are hereby notified that the County may determine whether the bidder is responsible based on a review of the bidder's performance on any contracts, including but not limited to County contracts. Particular attention will be given to violations of labor laws related to employee compensation and benefits, and evidence of false claims made by the bidder against public entities. This will include subcontractors and their employees as well. (Ord. 2291, § 1, 01/07/2003)
- C. The County may declare a bidder to be non-responsible for the purpose of this contract, if the Board of Supervisors, in its discretion, finds that the bidder has done any of the following: (1) committed any act or omission which negatively reflects on the bidder's quality, fitness or capacity to perform this contract with the County or a contract with any other public entity, or engaged in a pattern or practice which negatively reflects on same; (2) committed an act or omission which indicates a lack of business integrity or business honesty; or (3) made or submitted a false claim against the County or any other public entity. (Ord. 2291, § 1, 01/07/2003)
- D. If there is evidence that the apparent low bidder may not be responsible, the department shall notify the bidder in writing of the evidence relating to the bidder's responsibility, and its intention to recommend to the Board of Supervisors that the bidder be found not responsible. The department shall provide the bidder and/or the bidder's representative with an opportunity to present evidence as to why the bidder should be found to be responsible and to rebut evidence which is the basis for the department's recommendation. If the bidder fails to avail itself of the opportunity to rebut the department's evidence, the bidder may be deemed to have waived all rights of appeal. (Ord. 2291, § 1, 01/07/2003)
- E. If the bidder presents evidence in rebuttal to the department, the department shall evaluate the merits of such evidence, and based on that evaluation, make a recommendation to the Board of Supervisors. The final decision concerning the responsibility of the bidder shall reside with the Board of Supervisors. (Ord. 2291, § 1, 01/07/2003)
- F. These terms shall also apply to proposed [subcontracts/ sub-consultants] of bidders on County contracts. (Ord. 2291, § 1, 01/07/2003)

1.2 DETERMINATION OF BIDDER DEBARMENT

- A. The bidder is hereby notified that the County may debar the bidder from bidding on other County contracts for a specified period of time, not to exceed three (3) years, and the County may terminate any or all of the bidder's existing contracts with the County, if the Board of Supervisors finds, in its discretion, that the bidder has done any of the following: (1) violated any term of a contract with the County; (2) committed any act or omission which negatively reflects on the bidder's quality, fitness, or capacity to perform a contract with the County or any other public entity, or engaged in a pattern or practice which negatively reflects on same; (3) committed an act or offense which indicates a lack of business integrity or business honesty; or (4) made or submitted a false claim against the County or any other public entity. (Ord. 2291, § 1, 01/07/2003)
- B. If there is evidence that the apparent low bidder may be subject to debarment, the

department shall notify the bidder in writing of the evidence which is the basis for the proposed debarment, and shall advise the bidder of the scheduled date for a debarment hearing before the Contractor Hearing Board (CHB). (Ord. 2291, § 1, 01/07/2003)

- C. The CHB shall conduct a hearing where evidence on the proposed debarment is presented. The bidder and/or the bidder's representative shall be given an opportunity to submit evidence at that hearing. After the hearing, the CHB shall prepare a proposed decision, which shall contain a recommendation regarding whether the bidder should be debarred, and, if so, the appropriate length of time of the debarment. If the bidder fails to avail itself of the opportunity to submit evidence to the CHB, the bidder may be deemed to have waived all rights of appeal. (Ord. 2291, § 1, 01/07/2003)
- D. A record of the hearing, the proposed decision and any other recommendation of the CHB shall be presented to the Board of Supervisors, by the department head. The Board of Supervisors shall have the right to modify, deny or adopt the proposed decision and recommendation of the hearing board. (Ord. 2291, § 1, 01/07/2003)
- E. These terms shall also apply to proposed [subcontractors/ sub-consultants] of bidder's on County contracts. (Ord. 2291, § 1, 01/07/2003)

1.3 EVIDENCE OF RESPONSIBILITY / NONRESPONSIBILITY

(Humboldt County Code Sections 2141 et seq.)

The bidder shall, under penalty of perjury, answer each of the questions below and provide supporting documentation. The term "bidder" shall include any person associated with the bidder in the capacity of owner, partner, director, officer or manager.

- 1. Is the bidder under suspension, debarment, or determination of ineligibility by any federal, state or local agency? No Yes (explain)

- 2. Has the bidder been suspended, debarred, or determined ineligible by any federal, state or local agency within the preceding 5 years: No Yes (explain)

- 3. Is there pending against the bidder any proposed debarment or suspension proceeding? No Yes (explain)

- 4. Has the bidder been indicted, charged with, or convicted, or assessed civil or administrative penalties, or had a civil judgment rendered against it, in any matter involving:

- (a) fraud, false claims, or dishonesty;
- (b) any serious or wilful violation of the California Occupational Safety and Health Act of 1973 (Labor Code Sections 6300 et seq) or the Federal Occupational Safety and Health Act of 1970;
- (c) violation of the state workers' compensation laws;
- (d) violation of the Contractor's State License Law (Bus & Prof Code Sections 7000 et seq.)
- (e) violation of prevailing wage laws;
- (f) violation of state or federal environmental laws;
- (g) violation of local laws related to permits, land use, or waste disposal?

[] No [] Yes (explain)

5. Has the bidder defaulted on a construction contract within the preceding 10 years?

[] No [] Yes (explain)

6. Provide information concerning any bankruptcy or receivership of bidder, and information regarding all legal claims, disputes, or lawsuits (including administrative matters) arising from any construction project performed within the preceding 5 years, including information regarding any work completed by a surety.

NOTE: This information will not necessarily result in denial of award, but will be considered in determining bidder responsibility. Bidders are cautioned that making a false certification may subject the bidder to criminal prosecution.

Signature of Bidder: _____

Printed Name: _____

Date: _____

END OF SECTION

TO THE COUNTY OF HUMBOLDT, DEPARTMENT OF PUBLIC WORKS:

Non-Collusion Affidavit

(Title 23 United States Code Section 112 and Public Contract Code Section 7106)

In accordance with Title 23 United States Code Section 112 and Public Contract Code 7106 the Bidder declares that the Bid is not made in the interest of, or on behalf of, any undisclosed person, partnership, company, association, organization, or corporation; that the Bid is genuine and not collusive or sham; that the Bidder has not directly or indirectly induced or solicited any other Bidder to put in a false or sham bid, and they have not directly or indirectly colluded, conspired, connived, or agreed with any Bidder or anyone else to put in a sham bid, or that anyone shall refrain from bidding; that the Bidder has not in any manner, directly or indirectly, sought by agreement, communication, or conference with anyone to fix the bid price of the Bidder or any other Bidder, or to fix any overhead, profit, or cost element of the bid price, or of that of any other Bidder, or to secure any advantage against the public body awarding the contract of anyone interested in the proposed contract; that all statements contained in the bid are true; and further, that the Bidder has not directly or indirectly, submitted their bid price or any breakdown thereof, or the contents thereof, or divulged information or data relative thereto, or paid, and will not pay, any fee to any corporation, partnership, company association, organization, bid depository, or to any member of agent thereof to effectuate a collusive or sham bid.

Signature of Bidder

Date

Bidders are cautioned that making a false certification may subject the certifier to criminal prosecution.

END OF SECTION

Labor Code Section 3700.

"Every employer except the State shall secure the payment of compensation in one or more of the foregoing ways:

- A. By being insured against liability to pay compensation in one or more insurers duly authorized to write compensation insurance in this state.
- B. By securing from the Director of Industrial Relations a certificate of consent to self-insure either as an individual employer, or as one employer in a group of employers, which may be given upon furnishing proof satisfactory to the Director of Industrial Relations of ability to self-insure and to pay any compensation that may become due to their employees."

I am aware of the provisions of Section 3700 of the Labor Code which requires every employer to be insured against liability for workers' compensation or to undertake self-insurance in accordance with the provisions of that code, and that I will comply with such provisions before commencing the performance of the work of this contract.

Signature of Contractor

Printed Name

Date

In accordance with Article 5 [commencing at Section 1860], Chapter 1, Part 7, Division 2, of the Labor Code, the above certificate must be signed and filed with the awarding body prior to commencing any work under this contract.

END OF SECTION

TITLE 49, CODE OF FEDERAL REGULATIONS, PART 29

The CONTRACTOR, under penalty of perjury, certifies that, except as noted below, he/she or any other person associated therewith in the capacity of owner, partner, director, officer, manager:

- A. Is not currently under suspension, debarment, voluntary exclusion, or determination of ineligibility by any Federal, State or local agency;
- B. Has not been suspended, debarred, voluntarily excluded or determined ineligible by any Federal, State or local agency within the past 3 years;
- C. Does not have a proposed debarment pending; and
- D. Has not been indicted, convicted, or had a civil judgment rendered against it by a court of competent jurisdiction in any matter involving fraud or official misconduct within the past 3 years.

If there are any exceptions to this certification, insert the exceptions in the following space.

Exceptions will not necessarily result in denial of award, but will be considered in determining bidder responsibility. For any exception noted above, indicate below to whom it applies, initiating agency, and dates of action.

Notes: Providing false information may result in criminal prosecution or administrative sanctions. The above certification is part of the Proposal. Signing this Proposal on the signature portion thereof shall also constitute signature of this Certification.

Signature of Contractor

Printed Name

Date

END OF SECTION

In accordance with Public Contract Code Section 10232, the Contractor, hereby states under penalty of perjury, that no more than one final unappealable finding of contempt of court by a Federal court has been issued against the Contractor within the immediately preceding two year period because of the Contractor's failure to comply with an order of a Federal court which orders the Contractor to comply with an order of the National Labor Relations Board.

Signature of Bidder

Printed Name

Date

Bidders are cautioned that making a false certification may subject the certifier to criminal prosecution.

END OF SECTION

This is an AGREEMENT made and entered into this _____ day of _____, 2022 by and between the County of Humboldt, a political subdivision of the State of California (hereinafter referred to as COUNTY) and _____ a corporation organized and existing under the laws of the State of _____, a partnership consisting of _____, an individual doing business as _____ in the State of California, (hereinafter referred to as "CONTRACTOR").

County and Contractor for the consideration hereinafter named agree as follows:

SECTION 1 - SCOPE OF WORK

Contractor shall furnish all labor, tools and materials and perform all the work for the construction of:

**HUMBOLDT COUNTY COMMUNITY CORRECTIONS RE-ENTRY RESOURCE CENTER
PROJECT NUMBER: 170223**

in accordance with the Contract Documents referred to in Section 3 of this Agreement.

The scope of work includes the work included in the "Base Bid" for the project and the following bid alternatives: _____

SECTION 2 - CONTRACT PRICE

County shall pay, and Contractor shall accept Contractor's Price, as follows:

_____ Dollars and _____ /100 (\$ _____)

as full compensation for furnishing all materials and for doing all the work contemplated and embraced in this Agreement; also for all loss or damage, arising out of the work aforesaid, or from the actions of the elements, or from any unforeseen difficulties or obstructions which may arise or be encountered in the prosecution of the work until its acceptance by County, and for all risks of every description connected with the work; also for all expenses incurred by or in consequence of the suspension or discontinuance of the work and for well and faithfully completing the work, and the whole thereof, in the manner and according to the Plans and Specifications, and the requirements of the Owner.

SECTION 3 - CONTRACT DOCUMENTS

The complete contract between the parties hereto shall consist of the following, hereinafter referred to as the CONTRACT DOCUMENTS:

- | | |
|--------------------------------|----------------------------------|
| Notice to Contractors | General Conditions |
| Bid Form | Supplementary General Conditions |
| Bid Security Form | General Requirements |
| This Agreement | Technical Specifications |
| Payment Bond | Plans and Drawings |
| Performance Bond | Subcontractor List |
| Insurance Certificates | Noncollusion Affidavit |
| Public Contract Code Statement | Bidders Qualifications |

Special Conditions

Debarment and Suspension Certification

And, as published by the California Department of Industrial Relations:

General Prevailing Wage Rates

And any addenda to any of the above documents, all of which are on file in the office of the Director of Public Works of the County of Humboldt. Each of said CONTRACT DOCUMENTS is incorporated and made a part of this Agreement by the reference contained in this Section.

All rights and obligations of the County and the Contractor are fully set forth and described in the Contract Documents. All of the above named documents are intended to be complementary, so that any work called for in one, and mentioned in the other is to be performed and executed the same as if mentioned in all said documents.

SECTION 4 - BEGINNING OF WORK

Following receipt and full execution and approval of the Contract Documents, and posting of the requisite Bonds as called for therein, the COUNTY will issue a "Notice to Proceed". Under no circumstances shall the CONTRACTOR enter upon the site of work until receipt of the "Notice to Proceed", unless so authorized in writing by the COUNTY.

SECTION 5 - TIME OF COMPLETION

The work called for in this Agreement shall be commenced within ten (10) calendar days of the date of receipt by Contractor of the Notice to Proceed and shall be fully completed within 540 calendar days following receipt of the Notice to Proceed by the Contractor.

SECTION 6 - PREVAILING WAGE

Pursuant to Section 1770 of the Labor Code, the County has determined the Prevailing Wage Rate to be as listed by the Department of Industrial Relations, Division of Labor Statistics and Research, P.O. Box 420603, San Francisco, CA, 94101, Phone: (415) 703-4780. Complete Certified Payrolls must be submitted to the OWNER together with each application for progress payment. Electronic submittal directly to DIR may be required.

SECTION 7 - WORKERS' COMPENSATION

By my signature hereunder, as CONTRACTOR, I certify that I am aware of the provisions of Section 3700 of the Labor Code which requires every employer to be insured against liability for Workers' Compensation or to undertake self-insurance in accordance with the provisions of that code, and I will comply with such provisions before commencing the performance of the work of this contract.

SECTION 8 - NOTICES

All notices shall be in writing and delivered in person or transmitted by mail. Notices required to be given to the COUNTY shall be addressed as follows:

Humboldt County Department of Public Works
1106 Second Street
Eureka, CA 95501

Notices required to be given to CONTRACTOR shall be addressed as follows:

SECTION 9 - NUCLEAR FREE HUMBOLDT COUNTY ORDINANCE COMPLIANCE

Neither the Contractor, his Subcontractors or their suppliers are Nuclear Weapons Contractors, and are not knowingly or intentionally engaged in the research, development, production, or testing of nuclear warheads, nuclear weapons systems, or nuclear weapons components, as defined by the Nuclear Free Humboldt County Ordinance. Contractor, his Subcontractors and/or their suppliers agree to notify Owner immediately if they become a nuclear weapons contractor as defined above.

IN WITNESS WHEREOF, The parties hereto have entered into this Agreement as of the date first above set forth.

COUNTY OF HUMBOLDT

(SEAL)

By: _____
Chairperson, Board of Supervisors of the County of Humboldt, State of California

ATTEST:

By: _____
Clerk of the Board of Supervisors of the County of Humboldt, State of California

CONTRACTOR: Corporations require signature by two (2) corporate officers

By: _____

Title: _____

By: _____

Title: _____

APPROVED AS TO FORM:

By: _____
Deputy County Counsel

INSURANCE CERTIFICATES, PERFORMANCE AND PAYMENT BONDS REVIEWED AND APPROVED:

By: _____
Risk Manager

END OF SECTION

CONSTRUCTION PERFORMANCE BOND

This Construction Performance Bond ("Bond") is dated _____, is in the penal sum of _____ and is entered into by and between the parties listed below to ensure the faithful performance of the Construction Contract identified below. This Bond consists of this page and the Bond terms and Conditions, Paragraphs 1 through 13, attached hereto. Any singular reference to ("Contractor"), _____ ("Surety"), the County of Humboldt ("Owner") or other party shall be considered plural where applicable.

CONTRACTOR:

SURETY:

Name

Name

Address

Principal Place of Business

County of Humboldt
c/o Humboldt County Public Works
825 5th Street
Eureka, California 95501

CONSTRUCTION CONTRACT:
Humboldt County Community Corrections
Re-Entry Resource Center
Project #170223

Attn: Thomas K. Mattson
Director of Public Works

DATED _____, 20____, in
the amount of \$ _____.

CONTRACTOR AS PRINCIPAL
Company: _____ (Corp. Seal)

SURETY
Company: _____ (Corp. Seal)

Signature: _____

Signature: _____

Name and Title:

Name and Title:

BOND TERMS AND CONDITIONS

1. The Contractor and the Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors and assigns to Owner for the complete and proper performance of the Construction Contract, which is incorporated herein by reference.
2. If the Contractor completely and properly performs all of its obligations under the Construction Contract, the Surety and the Contractor shall have no obligation under this Bond.
3. The Surety's obligation under this Bond shall arise after:
 - A. Owner has declared a Contractor Default under the Construction Contract pursuant to the terms of the Construction Contract; and
 - B. Owner has agreed to pay the Balance of the undisputed Contract Sum to:
 1. The Surety in accordance with the terms of this Bond and the Construction Contract; or,
 2. To a contractor selected with the Owner's concurrence to perform the Construction Contract (per paragraph 4, below) in accordance with the terms of this Bond and the Construction Contract.
4. When Owner has satisfied the conditions of Paragraph 3, the Surety shall promptly, and in no event later than thirty (30) days after the Owner confirms in writing that it has satisfied the conditions of Paragraph 3, and at the Surety's sole expense, confirm in writing as to its election to take one of the following actions:
 - A. Arrange for the Contractor, with consent of Owner, to perform and complete the Construction Contract (but Owner may withhold consent in its sole discretion (with or without cause), in which case the Surety must immediately elect option 4B, 4C or 4D, below), and that such performance shall commence within an additional thirty (30) days; or
 - B. Undertake to perform and complete the Construction Contract itself, through its agents or through independent contractors, and that such performance shall commence within an additional thirty (30) days; or
 - C. As promptly as reasonably possible, obtain bids from qualified, responsible contractors acceptable to Owner for a contract for performance and completion of the Construction Contract, and, upon determination by Owner that the contractor selected with Owner's concurrence is responsible, and subject to full compliance with all applicable laws as may be required (including, without limitation, any applicable competitive bidding and public contracting and procurement requirements pursuant to California and/or Federal laws, if applicable), arrange for a contract to be prepared for execution by Owner and the contractor selected with Owner's concurrence, to be secured with performance and payment bonds executed by a qualified surety equivalent to the bonds issued on the Construction Contract and subject to the consent of Owner; and, if the Surety's obligations defined in Paragraph 6 exceed the Balance of the Contract Sum, then the Surety shall pay to Owner the amount of such excess; or
 - D. Waive its right to perform and complete, arrange for completion, or obtain a new contractor, and subject to its investigation and consultation with Owner, determine in good faith the amount for which it may then be liable to Owner under Paragraph 6 for the performance and completion of the Construction Contract and, within ten (10) additional calendar days, tender payment therefor to Owner with full explanation of the payment's calculation. If Owner accepts the Surety's tender under this paragraph 4(D), the Surety shall remain liable for future damages, then unknown or unliquidated, and including, without limitation, additional costs incurred to complete the Construction Contract and any unsatisfied liquidated damages, resulting from the Contractor Default. If Owner disputes

the amount of Surety's tender under this paragraph 4(D), Owner may exercise all remedies available to it at law to enforce the Surety's liability under paragraph 6.

5. If the Surety does not proceed as provided in Paragraph 4, then the Surety shall be deemed to be in default on this Bond ten (10) days after receipt of an additional written notice from Owner to the Surety demanding that the Surety perform its obligations under this Bond. At all times Owner shall be entitled to enforce any remedy available to Owner at law or under the Construction Contract including, without limitation, and by way of example only, rights to perform work, protect work, mitigate damages, or coordinate work with other consultants or contractors.
6. The Surety's monetary obligation under this Bond is limited by the amount of this Bond. Subject to these limits, the Surety's obligations under this Bond are commensurate with the obligations of the Contractor under the Construction Contract. The Surety's obligations shall include, but are not limited to:
 - A. The responsibilities of the Contractor under the Construction Contract for completion of the Construction Contract and correction of defective, deficient and/or non-compliant work;
 - B. The responsibilities of the Contractor under the Construction Contract to pay liquidated damages, and for damages for which no liquidated damages are specified in the Construction Contract, actual damages, and all damages caused by non-performance or lack of proper performance of the Construction Contract, including but not limited to, all valid and proper backcharges, offsets, payments, indemnities, and/or other damages;
 - C. Additional administrative, management, legal, design professional and delay costs resulting from the Contractor Default or resulting from the actions or failure to act of the Surety under Paragraph 4.
7. No right of action shall accrue on this Bond to any person or entity other than Owner or its heirs, executors, administrators, or successors.
8. The Surety hereby waives notice of any change, alteration or addition to the Construction Contract or to related subcontracts, purchase orders and other obligations, including changes of time. The Surety consents to all terms of the Construction Contract, including provisions on changes to the Contract. No extension of time, change, alteration, modification, deletion, or addition to the Contract Documents, or of the work required thereunder, shall release or exonerate Surety on this Bond or in any way affect the obligations of Surety on this Bond.
9. Any proceeding, legal or equitable, under this Bond shall be instituted in the Superior Court for the County of Humboldt.
10. As a part of the obligation secured under this Bond, and in addition to the face amount specified therefore, there shall be included costs and reasonable expenses and fees, including reasonable attorney's fees and expert costs, incurred by the County in successfully enforcing any obligation arising under this Bond, all to be taxed as costs and included in any judgment rendered
11. Notice to the Surety, Owner or the Contractor shall be mailed or delivered to the address shown on the signature page.
12. Any provision in this Bond conflicting with any statutory or regulatory requirement shall be deemed deleted herefrom and provisions conforming to such statutory requirement shall be deemed incorporated herein.
13. Definitions.
 - A. Balance of the Contract Sum: The total amount payable by Owner to the Contractor pursuant to the terms of the Construction Contract after all proper adjustments have been

made under the Construction Contract, for example, deductions for progress payments made, and increases/decreases for approved modifications to the Construction Contract.

- B. Construction Contract: The agreement between Owner and the Contractor identified on the signature page, including all Contract Documents and changes thereto.
- C. Contractor Default: Material failure of the Contractor, which has neither been remedied nor waived, to perform or otherwise to comply with the terms of the Construction Contract.

END OF SECTION

SECTION 00 61 14 - PAYMENT BOND

KNOW ALL MEN BY THESE PRESENTS, THAT WHEREAS, the County of Humboldt, by its order made _____, 20____, has awarded to _____, hereinafter designated as the "Principal," a contract for the work described as follows:

NOW, THEREFORE, we the Principal and Surety, are held and firmly bound unto the County of Humboldt in the penal sum of Dollars (\$ _____), lawful money of the United States of America for the payment of which sum well and truly to be made, we bind ourselves, our heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents.

THE CONDITION OF THIS OBLIGATION IS SUCH that if said Principal, his/her or its heirs, executors, administrators, successors or assigns, shall fail to pay any of the persons named in Section 9100 of the Civil Code, or amounts due under the Unemployment Insurance Code with respect to work or labor performed by any such claimant, any prevailing wages due and penalties incurred pursuant to the California Labor Code or for any amounts required to be deducted, withheld, and paid over to the Franchise Tax Board from the wages of employees of the Contractor and their subcontractors pursuant to Section 18806 of the Revenue and Taxation Code with respect to such work and labor as required by Sections 9550 et seq. of the Civil Code of California, then said Surety will pay for the same, in or to an amount not exceeding the amount set forth herein, and also will pay in case suit is brought upon this bond, such reasonable attorney's fees, as shall be fixed by the court, awarded and taxed as in the above-mentioned statutes provided.

AND, the said Surety, for value received, hereby stipulates and agrees that no change, extension of time, alteration or addition to the terms of the contract or to the work to be performed thereunder or the specifications accompanying the same shall in any wise affect its obligations on this bond, and it does hereby waive notice of any such change, extension of time, alteration or addition to the terms of the contract, or to the work, or to the specifications.

IN WITNESS WHEREOF, this instrument has been duly executed by the Principal and Surety above named, on the _____ day of _____, 20 ____.

PRINCIPAL

SURETY

BY: _____

BY _____
ATTORNEY-IN-FACT

END OF SECTION

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Administrative and procedural requirements for alternates.

1.2 DEFINITIONS

- A. Alternate: An alternate is an amount proposed by bidders and stated on the Bid Form that will be added to or deducted from Base Bid amount if the Owner decides to accept a corresponding change in either scope of work or in products, materials, equipment, systems or installation methods described in Contract Documents.

1.3 PROCEDURES

- A. Coordination: Modify or adjust affected adjacent work as necessary to completely integrate work of the alternate into Project.
 - 1. Include as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation whether or not indicated as part of alternate.
- B. Notification: Immediately following award of the Contract, notify each party involved, in writing, of the status of each alternate. Indicate if alternates have been accepted, rejected, or deferred for later consideration. Include a complete description of negotiated modifications to alternates.
- C. Execute accepted alternates under the same conditions as other work of the Contract.
- D. Schedule: A listing of Bid Alternates is included on the Bid Form. Specification sections referenced in the Schedule contain requirements for materials necessary to achieve the Work described under each alternate.
 - 1. Include as part of each alternate, miscellaneous devices, appurtenances and similar items incidental to or required for a complete installation whether or not mentioned as part of the alternate.
 - 2. State on the Bid Form amounts that will be ADDED to or DEDUCTED from the Basic Bid amount for the work described in the listing of Bid Alternates included on the Bid Form.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

INDEX TO GENERAL CONDITIONS

GC	1.	DEFINITIONS	3
GC	2.	CONTRACT	4
GC	3.	BONDS	5
GC	4.	INSURANCE REQUIREMENTS	5
GC	5.	DEFAULT/TERMINATION OF CONTRACT	12
GC	6.	INDEMNIFICATION	16
GC	7.	ASSIGNMENT OF CONTRACT	16
GC	8.	SEPARATE CONTRACTS	17
GC	9.	CONFERENCES	17
GC	10.	TERMS OF PAYMENT	17
GC	11.	CONFLICTS OR ERRORS	22
GC	12.	CHANGES IN THE WORK	22
GC	13.	GUARANTEE	26
GC	14.	INTERPRETATIONS	26
GC	15.	DECISIONS BY ARCHITECT AND / OR OWNER'S REPRESENTATIVE	26
GC	16.	ADMINISTRATION OF THE CONTRACT	27
GC	17.	NON-CONFORMING WORK	28
GC	18.	OWNERSHIP OF DOCUMENTS	29
GC	19.	DOCUMENTS FURNISHED	29
GC	20.	DRAWING DIMENSIONS	29
GC	21.	DETAILED DRAWINGS	29
GC	22.	SUBMITTALS	29
GC	23.	SURVEY AND LAYOUT	30
GC	24.	UNITY OF DOCUMENTS	31
GC	25.	INSPECTION BY CONTRACTOR	31
GC	26.	DEVIATION FROM PLANS OR SPECIFICATIONS	32
GC	27.	STANDARDS OF MATERIALS	32
GC	28.	QUALITY OF MATERIALS AND LABOR	32
GC	29.	DELIVERY AND STORAGE OF MATERIALS	32
GC	30.	OLD MATERIAL	32
GC	31.	TESTS	33
GC	32.	PATENT RIGHTS, COPYRIGHTS, TRADE NAMES AND ROYALTIES	33
GC	33.	COMPLIANCE WITH ALL LAWS	33
GC	34.	PERMITS AND LICENSES	34
GC	35.	TEMPORARY FACILITIES	34
GC	36.	LIABILITY FOR ACCIDENTS	35
GC	37.	ACCIDENT PREVENTION	35

GC	38.	EXISTING PREMISES AND IMPROVEMENTS	36
GC	39.	USE OF PREMISES AND CLEAN-UP	36
GC	40.	DIRECTION OF THE WORK	37
GC	41.	CUTTING, FITTING AND PATCHING	40
GC	42.	RIGHT TO OCCUPY OR USE	40
GC	43.	CHANGE OF CONTRACT TIME LIMIT & LIQUIDATED DAMAGES	41
GC	44.	HOURS OF WORK	42
GC	45.	PREVAILING WAGE RATES & PAYROLL RECORDS	43
GC	46.	TAXES	44
GC	47.	SUBCONTRACTORS	44
GC	48.	RECORDS, ACCOUNTS AND SEGREGATED PRICES	46
GC	49.	LIABILITY FOR TREES	47
GC	50.	LIABILITY FOR SURVEY MARKS	47
GC	51.	CLAIMS PROCEDURES	47
GC	52.	HAZARDOUS MATERIALS AND / OR DIGGING TRENCHES	51
GC	53.	NONDISCRIMINATION	51
GC	54.	RESPONSIBILITY FOR COMPLIANCE WITH OSHA	52
GC	55.	NUCLEAR FREE HUMBOLDT COUNTY ORDINANCE COMPLIANCE	52
GC	56.	DISCOVERY OF HUMAN REMAINS OR AN ARCHAEOLOGICAL SITE	52
GC	57.	CONTRACTOR RESPONSIBILITY AND DEBARMENT	53
GC		APPENDIX A: CLAIMS RELATING TO PUBLIC CONTRACTS	54
GC		APPENDIX B: CLAIMS EQUAL TO OR LESS THAN \$375,000	57

GC 1. DEFINITIONS

- A. COUNTY: The term "County", or pronouns in place of same where used herein, shall mean Humboldt County acting through its Board of Supervisors.
- B. BOARD: The term "Board", or pronouns in place of same where used herein, shall mean the Humboldt County Board of Supervisors.
- C. OWNER: The "Owner" is the County and is the person or entity identified as such in the Owner-Contractor Agreement; the term Owner means the Owner or its authorized representative.
- D. ARCHITECT: The term "Architect" shall mean the licensed professional architect in responsible charge of the design of the project employed or contracted by the Humboldt County Department of Public Works as the authorized representative of the Owner.
- E. CONTRACTOR: The term "Contractor" or "General Contractor", where used herein, shall mean the Contractor licensed by the California Contractors State License Board to whom the contract for the work described and specified herein has been awarded by the Humboldt County Board of Supervisors or their authorized representative.
- F. PLANS AND SPECIFICATIONS: The term "Plans and Specifications", where used herein, shall mean and include all specifications and provisions of every kind, whether general, detailed or otherwise, relating to the equipment, material or Work, and the installation thereof, and the plans and drawings accompanying same which are made a part thereof. Such Plans and Specifications are recognized as instruments of professional service.
- G. OWNER'S REPRESENTATIVE: The term "Owner's Representative" shall mean the agent or independent qualified consultant assigned to the Project by Humboldt County Department of Public Works. The Owner's Representative shall not be responsible for means, methods, techniques, sequences or procedures of construction, nor be responsible for the Contractor's failure to carry out the Work in accordance with the Contract Documents.
- H. CONSTRUCTION ADMINISTRATOR: The term "Construction Administrator" shall mean the agent or independent qualified consultant assigned to the Project by Humboldt County Department of Public Works. The Construction Administrator may be a separate agent or may also perform the function of the Project Inspector or Owner's Representative. The Construction Administrator will be the prime point of contact between the Contractor and Owner. The Construction Administrator will log, route, and maintain all project communications and documentation including, but not limited to, letters of instruction, contractor letters, requests for information, submittals, cost proposals and changes to the work.
- I. PROJECT INSPECTOR: The term "Project Inspector" shall mean the agent or independent qualified consultant assigned to the Project by Humboldt County Department of Public Works to perform the following services: Observe the performance of Project labor, installation of all materials and equipment to be incorporated into the Work and the placing of such materials and equipment to determine in general if the Work is proceeding in accordance with the Contract Documents as defined in section 00 52 00 "Agreement Forms". On the basis of such observations, the Project Inspector will keep the Owner's Representative informed as to the progress of the Work. The Project Inspector shall not be responsible for means, methods, techniques, sequences or procedures of construction, nor be responsible for the Contractor's failure to carry out the Work in accordance with the Contract Documents.
- J. SURETY: The term "Surety" shall mean the surety or sureties that issue the Payment Bond and/or the Performance Bond required by the Contract Documents.

- K. CONTRACT or AGREEMENT: "Contract" or "Agreement" shall mean the agreement signed by County and Contractor (Section 00 52 00) and shall also mean the totality of the contractual obligations of Contractor hereunder.
- L. CONTRACT PRICE: "Contract Price" shall mean the amount set forth as the contract price in the Agreement (Section 00 52 00).
- M. CONTRACT TIME: "Contract Time" shall mean the time for completion of the Work required by the Contract Documents as set forth in the Agreement (Section 00 52 00),
- N. PROJECT: The "Project" is the total construction of which the Work performed under the Contract Documents may be the whole or a part.
- O. SUBSTANTIAL COMPLETION: "Substantial Completion", shall mean that the Work is sufficiently complete, in accordance with the Contract Documents, that the County can occupy or utilize the Work or a designated portion thereof for the use for which it is intended.
- P. WORK: The "Work" comprises the completed construction required by the Contract Documents and approved change orders and includes all labor necessary to produce such construction, and all materials and equipment incorporated or to be incorporated in such construction.

Capitalized terms not defined in these General Conditions shall have the same meaning as defined in other Contract Documents.

GC 2. CONTRACT

- A. The Contract Documents include all documents identified as such in the Agreement (Section 00 52 00), and any amendments and Change Orders thereto
- B. In the execution of the Work or any portion thereof, Contractor shall operate as an independent contractor and not as the agent of Owner or Architect.
- C. No verbal agreement or conversation with any officer, agent, or employee of Owner or Architect, either before or after execution of the Agreement, shall affect or modify any terms or obligations of the Contract unless duly incorporated into the Contract by written Change Order or amendment of the Contract.
- D. The Contract Documents shall not be construed to create any contractual relationship of any kind between the Architect and the Contractor, but the Architect shall be entitled to performance of obligations intended for its benefit, and to enforcement thereof. Nothing contained in the Contract Documents shall create any contractual relationship between the Owner or the Architect and any subcontractor or sub-subcontractor.
- E. By executing the Contract, the Contractor represents that Contractor has visited the Project site, familiarized itself with the local conditions under which the Work is to be performed, and correlated its observations with the requirements of the Contract Documents.
- F. The intent of the Contract Documents is to include all items necessary for the proper execution and completion of the Work. The Contract Documents are complementary, and what is required by any one shall be as binding as if required by all. Contractor shall perform all work set forth in the Contract Documents and reasonably inferable therefrom as being necessary to produce the intended results. Words and abbreviations which have well-known technical or trade meanings are used in the Contract Documents in accordance with such recognized meanings.

Whenever two or more standards or requirements appear in the Contract Documents, the highest standard or requirement shall be applied and followed in the performance under this Contract. If a conflict cannot be so resolved, the following shall apply:

- (a) In cases of discrepancy concerning dimension, quantity and location, the Plans shall take precedence over the Specifications. Explanatory notes on the Plans shall take precedence over conflicting drawn indications. Large-scale details shall take precedence over smaller scale details and figured dimensions shall take precedence over scaled measurement. Where figures are not shown, scale measurements shall be followed but shall in all cases be verified by measuring actual conditions of Work already in place. In cases of discrepancy concerning application of materials and non-technical requirements over materials, the specifications shall take precedence over Plans.
- (b) For all other conflicts between terms of the Contract Documents that cannot be resolved as set forth above, the following order of precedence shall apply:
 - 1. The Contract
 - 2. The Supplementary Conditions
 - 3. The General Conditions
 - 4. The Specifications
 - 5. The Plans.

G. The organization of the Specifications into divisions, sections and articles, and the arrangement of drawings shall not control the Contractor in dividing the Work among subcontractors or in establishing the extent of Work to be performed by any trade.

GC 3. BONDS

- A. Contractor, simultaneously with the execution of the Agreement, will be required to furnish a Payment Bond in an amount equal to one hundred (100%) percent of the Contract Price, and a faithful Performance Bond in an amount equal to one hundred (100%) percent of the Contract Price. The Contractor must submit a certificate with all bonds indicating that the Surety is admitted to transact business in the State of California, and certify that the Surety's certificate of authority, issued by the Insurance Commissioner, has not been suspended, revoked, canceled, or annulled.
- B. The bonds shall comply with Section 9554 of the Civil Code of the State of California. The Payment Bond and the faithful Performance Bond shall each be in a form that is satisfactory to the County Counsel, or Risk Management of the County of Humboldt. A copy of an acceptable format is attached to the Agreement forms of these specifications.
- C. All Bonds shall meet or exceed A.M. Best's Long-Term Issuer Credit Rating (Long-Term ICR) Scale categories of Rating Category: **Excellent**; Rating Symbol: **a**; Rating Notch: **a+**, and Short-Term Issuer Credit Rating (Short-Term ICR) Scale categories of Rating Category: **Outstanding**; Rating Symbol: **AMB-1**, and Best's Financial Strength Rating (FSR) Scale categories of Rating Category: **Excellent**, Rating Symbol: **A**, Rating Notch: **A-**. All bonds shall be written by a surety company licensed through the California Department of Insurance and shall have a physical presence in the State of California. Companies providing reinsurance to the surety company shall also be a surety company licensed through the California Department of Insurance and shall have a physical presence in the State of California. The Bid Bond, Payment Bond and Performance Bond shall all be written by the same surety company. If cash or securities are provided in lieu of a Bid Bond, then both the Payment Bond and Performance Bond shall both be written by the same surety company. "Off-shore" surety companies and/or reinsuring sureties or companies shall not be accepted.

GC 4. INSURANCE REQUIREMENTS

- 1. OWNER CONTROLLED INSURANCE PROGRAM. OWNER shall implement an Owner Controlled Insurance Program ("OCIP") for the Project. The OCIP is more fully described in the insurance manual (the "Insurance Manual") for the Project, which is incorporated herein by this reference as a Contract Document. OWNER has designated Alliant Insurance Services, Inc. as the OCIP Administrator ("OCIP Administrator") for the Project. The OCIP will include Workers' Compensation and Employer's Liability insurance, Commercial General Liability insurance, and Excess Liability insurance, as summarily described below, in connection with the Project. The insurance provided

under the OCIP shall be referred to herein as "OCIP Coverages."

2. Eligible and Enrolled Parties. Parties eligible to enroll in the OCIP are the Contractor, and Subcontractors performing a portion of the Work on the Project site ("Eligible Parties"). Upon enrollment, an Eligible Party shall become an "Enrolled Party."
3. Excluded Parties. Parties that are not eligible to enroll in the OCIP, and who are excluded from the OCIP, are:
 - (a) Hazardous materials remediation, removal and/or transport companies and their consultants;
 - (b) Architects, surveyors, engineers, and soil testing engineers, and their consultants;
 - (c) Vendors, suppliers, fabricators, material dealers, truckers, haulers, drivers and others who merely transport, pick up, deliver, or carry materials, personnel, parts or equipment, or any other items or persons to or from the Project site;
 - (d) Any Subcontractor of any tier that does not perform any actual labor on the Project site; and
 - (e) Any other party or entity not specifically identified herein, that is excluded by OWNER in its sole discretion, even if such party or entity is otherwise eligible.
4. Summary of OCIP Coverages. The OCIP Coverages shall apply only to those operations of each Enrolled Party performed at the Project site in connection with the Work, and only to Enrolled Parties that are eligible for the OCIP. OCIP Coverages shall not apply to ineligible parties, even if they are erroneously enrolled in the OCIP. An Enrolled Party's operations away from the Project site, including product manufacturing, assembling, or otherwise, shall only be covered if such off-site operations are identified and are dedicated solely to the Project. OCIP Coverages shall not cover off-site operations until the Enrolled Party requesting off-site coverage receives written acknowledgment of such coverage from the OCIP Administrator. A summary of the coverages provided under the OCIP is set out below.

SUMMARY OF OCIP COVERAGES

A. Workers' Compensation/Employer's Liability Insurance

Worker's Compensation Employer's Liability	Statutory Limit
Bodily Injury By Accident, each accident	\$1,000,000
Bodily Injury By Disease, each employee	\$1,000,000
Bodily Injury By Disease, policy limit	\$1,000,000

**B. Commercial General Liability Insurance
Form Equivalent to Most Current ISO Occurrence Form**

Each Occurrence Limit	\$2,000,000
Personal/Advertising Injury Limit (Each Occurrence)	\$2,000,000
General Aggregate Limit for all Enrolled Parties (Other Than Products/Completed Operations)	\$8,000,000
Products and Completed Operations Aggregate (for all Enrolled Parties)	\$4,000,000
Fire Damage Legal Liability (any one fire)	\$300,000
Medical Payments (any one person)	\$ 10,000

C. Excess Liability Insurance (over Commercial General Liability)

Combined Single Limit	\$100,000,000
General Annual Aggregate for all Enrolled Parties	\$100,000,000
Products & Completed Operations Aggregate (for all Enrolled Parties)	\$100,000,000
Ten (10) Years Products & Completed Operations Extension	

D. The following additional coverages are provided for the participants in the project by OWNER outside of the OCIP:

D1. Contractor's Pollution Liability Insurance

Per Occurrence	\$10,000,000
Aggregate	\$20,000,000
Ten (10) Years Products & Completed Operations Extension	

D2. Builders Risk

The OWNER shall obtain and maintain in force during the term of this Agreement a Builders' Risk Insurance policy or policies separate from the OCIP, which shall insure against all risks of physical loss and/ or damage including flood and earthquake, subject to normal policy exclusions, to all buildings, structures, materials, and real property on site, which are intended to be, or have already been incorporated into and forming part of the Project, whether or not such buildings, structures, materials, or real property will have been supplied or made available to Contractors by OWNER.

The Builders' Risk policy shall be endorsed to add Contractors of any tier as additional named insureds', as their interests may appear and to waive the carrier's right of recovery under subrogation against OWNER and all other Contractors of any tier whose interests are insured under such policy.

Unless required otherwise by OWNER, claims under Builders' Risk insurance provided are subject to a Contractor Claims Obligation of five thousand dollars (\$5,000) per occurrence. If a claim results from any construction activity, the responsible Contractor, Subcontractor, or Sub-Subcontractor shall pay the Contractor Claims Obligation up to \$5,000. All Builders' Risk losses will be adjusted with and payable to the OWNER or the Designee for the benefit of all parties as their interest may appear.

The OWNER shall not be responsible for loss or damage to, or obtaining and/or maintaining in force insurance on temporary structures, construction equipment, tool or personal effects, owned or rented to or in the care, custody, and control of a Contractor of any tier.

5. OWNER'S OCIP Obligations. OWNER shall pay the costs of premiums for the OCIP Coverages. OWNER will receive or pay, as the case may be, all adjustments to such costs, whether by way of dividends, retroactive adjustments, return premiums, other moneys due, audits or otherwise. CONTRACTOR hereby assigns to OWNER the right to receive all such adjustments. All Subcontractors shall be required, by written contract to assign to OWNER the right to receive all such adjustments. OWNER assumes no obligation to provide insurance other than that specified in this specification section "GC 4. INSURANCE REQUIREMENTS" and in the OCIP insurance policies. OWNER'S furnishing of OCIP Coverages shall in no way relieve or limit, or be construed to relieve or limit, any responsibility, liability, or obligation imposed up CONTRACTOR, or any Subcontractor, under the Contract Documents, the OCIP insurance policies, or by law, including, without limitation, any indemnification obligations which such parties have agreed. OWNER reserves the right at its option, without obligation to do so, to furnish other insurance coverage of various types and limits provided that such coverage is not less than that specified in this section "GC 4. INSURANCE REQUIREMENTS."

6. CONTRACTOR'S OCIP OBLIGATIONS.

6(a). CONTRACTOR shall incorporate by reference the insurance requirements set out in this specification section "00 72 00, GC 4. INSURANCE REQUIREMENTS", into all Subcontractor agreements.

6(b). CONTRACTOR shall enroll in the OCIP prior to the commencement of construction activities at the Project. CONTRACTOR shall ensure that all Subcontractors who are Eligible Parties

enroll in the OCIP prior to their commencement of construction activities at the Project.

- 6(c). CONTRACTOR shall comply with all of the requirements of the OCIP insurance policies, and the OCIP Insurance Manual. CONTRACTOR shall provide to each of its Subcontractors of every tier a copy of the Insurance Manual, and require Subcontractor compliance with all provisions of the OCIP insurance policies, and the OCIP Insurance Manual.
 - 6(d). CONTRACTOR shall acknowledge, and require all of its Subcontractors of every tier to acknowledge, in writing, that OWNER and the OCIP Administrator are not agents, partners or guarantors of any OCIP insurer, that neither OWNER nor the OCIP Administrator are responsible for any claims or disputes between or among CONTRACTOR, its Subcontractors of any tier, and any OCIP Insurer(s), and that neither OWNER nor OCIP Administrator guarantees the solvency or the availability of limits of any OCIP Insurer(s).
 - 6(e). CONTRACTOR shall Provide, within five (5) days of OWNERS request, any information related to CONTRACTOR's insurance costs, including but not limited to payroll records, certified copies of insurance coverages, declaration pages of coverages, certificates of insurance, underwriting data, prior loss history information, safety records or history, OSHA citations, construction cost estimates for this Project, or such other data or information as OWNER, the OCIP Administrator, or OCIP Insurers may request in the administration of the OCIP. CONTRACTOR shall require its Subcontractors to provide the same information, upon request.
 - 6(f). CONTRACTOR shall comply, and require all of its Subcontractors to comply with OCIP Administrator's instructions for electronically enrolling in the OCIP.
 - 6(g). Cost of Work Excludes Cost of OCIP Insurance. CONTRACTOR and each Subcontractor shall exclude from their bids all costs of insurance coverage provided under the OCIP ("Cost of OCIP Coverages.") Cost of OCIP Coverages is defined as the amount of CONTRACTOR's and its Subcontractors' reduction in insurance costs due to eligibility for the OCIP, and included reduction in insurance premiums, related taxes and assessments, markup on the insurance premiums and losses retained through the use of the self-funded program, self-insured retention, or deductible program. Change orders must also be priced to exclude the Cost of OCIP Coverages.
7. **ADDITIONAL INSURANCE REQUIRED FROM ENROLLED PARTIES AND EXCLUDED PARTIES.** CONTRACTOR shall obtain and maintain, and shall require each of its Subcontractors of all tiers to obtain and maintain, the insurance coverage specified herein in a form and from insurance companies reasonably acceptable to OWNER. The insurance limits may be provided through a combination of primary and excess policies, including the umbrella form of policy. Each policy required herein, except the Workers' Compensation policy, shall name OWNER, the OCIP Administrator, their respective officers, agents and employees, and any additional entities as OWNER may request as additional insureds. The additional insured endorsement shall state that the coverage provided to the additional insureds is primary and non-contributory with respect to any other insurance available to the additional insureds. CONTRACTOR shall provide certificates of insurance evidencing all required coverage prior to commencement of Work. The additional insured endorsement to the general liability policy shall be provided by issuance of both ISO Form CG 2010 1001 and ISO Form CG 2037 1001 additional insured endorsements, or such other endorsement as acceptable to OWNER.

Enrolled Parties shall provide Worker's Compensation, Employer's Liability, General Liability, and Excess Liability insurance, as set out below, for off-site activities, and Automobile Liability insurance for all activities, both on-site and off-site.

Excluded Parties must provide all insurance set out below for both on-site and off-site activities.

- 7(a). Standard Commercial Automobile Liability Insurance covering all owned, non-owned, and hired automobiles, trucks, and trailers with a combined single limit of not less than

\$1,000,000 for bodily injury, \$1,000,000 for property damage, and with a \$1,000,000 policy limit.

- 7(b). Statutory Workers' Compensation Insurance and Employer's Liability insurance with statutory limits as required by law, including Maritime coverage, if appropriate, and Employer's Liability limits of not less than \$1,000,000 each accident, \$1,000,000 each employee, and with a \$1,000,000 policy limit.
- 7(c). Commercial General Liability Insurance in a form providing coverage not less than the standard ISO Commercial General Liability insurance policy ("Occurrence Form"), with limits no less than:

<u>Parties</u>	<u>Enrolled Parties Excluded</u>	
Each Occurrence	\$1,000,000	\$2,000,000
General Aggregate	\$2,000,000	\$4,000,000
Products/Completed Operations Aggregate	\$2,000,000	\$4,000,000
Personal/Advertising Injury Aggregate	\$1,000,000	\$2,000,000

- 7(d). If required by OWNER, Aviation and/or Watercraft Liability Insurance or other insurance, in form and with limits of liability and from an insuring entity reasonably satisfactory to the OWNER.
- 7(e). Professional Liability. In the event any contract specifications requires CONTRACTOR to perform professional services, such as but not limited to, architectural, engineering, construction management, surveying, or design, CONTRACTOR shall maintain a Professional Liability policy with limits not less than two million dollars (\$2,000,000) per claim and four million (\$4,000,000) aggregate.
- 7(f). Pollution Liability. Contractor shall purchase and thereafter maintain Pollution Liability insurance in the amount of not less than one million dollars (\$1,000,000) per claim and in the aggregate covering liability arising from the sudden and accidental release of pollution on the project site. CONTRACTOR or its subcontractors, if involved with the removal of asbestos or lead, the removal/replacement of underground tanks, or use of toxic chemicals and substances, shall purchase and thereafter maintain Pollution Liability insurance in the amount of not less than five million dollars (\$5,000,000) per claim and five million (\$5,000,000) aggregate.
- 7(g). All insurance referred to herein to be carried by CONTRACTOR or any Subcontractor shall be maintained by such parties at their sole expense, with insurance carriers qualified to do business in California and having a rating of not less than A-: VII or better from A.M. Best & Co., unless OWNER, in writing, in its sole discretion, accepts a lower Best's rating.
- 7(h). OWNER reserves the right to require (1) higher limits and (2) additional insurance coverages if OWNER determines in its sole discretion that such higher limits and/or additional coverages are reasonably necessary for the protection of OWNER. Such additional coverages shall be in a form and with limits of liability, additional insured endorsements, and deductibles or self-insured retentions acceptable to OWNER.
- 7(i). Prior to commencing work at the project, CONTRACTOR shall deliver to OWNER the endorsements and waivers of subrogation referred to herein, as well as certificates of insurance evidencing the coverages required herein. Promptly upon OWNER's request, CONTRACTOR shall deliver to OWNER a copy of any and all of the insurance policies and other insurance documents required hereunder. In the case of policies expiring while work is in progress, a renewal certificate with all applicable endorsements must be delivered to OWNER prior to the expiration of the existing policy or policies. Permitting CONTRACTOR or any Subcontractor to start work, or continue work, prior to compliance with these requirements shall not constitute a waiver of any of the requirements set forth herein. All certificates of insurance must provide OWNER with thirty (30) days advance written notice of

cancellation, intent to non-renew, or adverse material change in or reduction of coverage.

8. Representations and Warranties. CONTRACTOR represents and warrants to OWNER, and shall use its best efforts to ensure that each of its Subcontractors of every tier represent and warrant to OWNER that:
 - 8(a). All information they submit to OWNER, or to the OCIP Administrator, shall be accurate and complete.
 - 8(b). They have had the opportunity to read and analyze copies of the OCIP insurance policies that are available on request, and that they understand the OCIP Coverages. Any reference or summary in this Agreement, to the amount, nature, type or extent of OCIP Coverages and/or potential applicability to any potential claim or loss is for reference only. CONTRACTOR and its Subcontractors of all tiers have not relied upon said reference, but solely upon their own independent review and analysis of the OCIP Coverages in formulating any understanding and/or belief as to amount, nature, type or extent of any OCIP Coverages and/or its potential applicability to any potential claim or loss.
 - 8(c). CONTRACTOR shall not include in any request for payment any sums to provide or obtain insurance that is being maintained under the OCIP.
9. Audits. CONTRACTOR and all Subcontractors agree that OWNER, the OCIP Administrator, and/or any OCIP insurer may audit their payroll records, books and records, insurance coverages, insurance cost information, and project cost records to confirm their accuracy, and to ensure that the OWNER has not been billed for any cost of insurance that is being provided under the OCIP. In the event any audit reveals that OWNER has been billed by CONTRACTOR or any of its Subcontractors for any cost of insurance that is being provided by OWNER under the OCIP, OWNER shall have the right to deduct from any amounts payable to CONTRACTOR or any Subcontractor such cost, including all expenses and fees of audit.
10. Modification or Discontinuance of the OCIP. OWNER may, for any reason, modify the OCIP Coverages, discontinue the OCIP, or request that CONTRACTOR or any of its Subcontractors of any tier withdraw from the OCIP upon thirty (30) days written notice. Upon such notice CONTRACTOR and/or one or more of its Subcontractors, as specified by OWNER in such notice, shall obtain and thereafter maintain during the performance of the Work, such insurance as specified by OWNER. The form, content, limits of liability, cost, and the insurer issuing such replacement insurance shall be subject to OWNER's approval. The cost of the replacement coverage shall be at OWNER's expense, but only to the extent of the Cost of OCIP Coverages.
11. Waiver of Subrogation. Where permitted by law, CONTRACTOR hereby waives all rights of recovery by subrogation because of deductible clauses, inadequacy of limits of any insurance policy, limitations or exclusions of coverage, or any other reason against OWNER, the OCIP Administrator, its or their officers, agents, or employees, and any other Subcontractor performing Work or rendering services on behalf of OWNER in connection with the planning, development and construction of the Project. CONTRACTOR also agrees that all additional insurance maintained by CONTRACTOR or any Subcontractor under this specification section "GC 4. INSURANCE REQUIREMENTS" shall include clauses providing that each insurer shall waive all of its rights of recovery by subrogation against OWNER, CONTRACTOR, or any Subcontractor. A waiver of subrogation shall be effective as to any individual or entity even if such individual or entity (a) would otherwise have a duty of indemnification, contractual or otherwise, (b) did not pay the insurance premium directly or indirectly, and (c) whether or not such individual or entity has an insurable interest in the property damaged.
12. Conflicts. In the event of a conflict between the provisions of this Article, the Insurance Manual, and the provisions of the OCIP insurance policies, the terms of the OCIP Insurance Policies shall govern, then the provisions of this Article, then the provisions of the Insurance Manual.
13. Safety. CONTRACTOR is solely responsible for all construction means, methods, safety, techniques, sequences, and procedures. Each subcontractor, of any tier, is responsible for all safety precautions and programs in connection with work under CONTRACTOR's agreement. The requirements of

Cal/OSHA, state, county and city laws, statutes, regulations, codes, ordinances, and orders of those governing bodies having jurisdiction over the work, including the OCIP specific safety specifications listed below, establish the guidelines for this project that safety and loss prevention programs must meet or exceed. In the event of a conflict or inconsistency, the most stringent standard will govern.

13(a). Project Safety Team Monthly meetings. The Project Safety Team is a safety committee for the project. Each project shall have a committee comprised of CONTRACTOR, Subcontractor, Project Manager and/or OCIP Safety Representative. On a monthly basis the group shall meet to discuss the projects safety program. These meetings may be incorporated into project coordination meetings.

13(b). Drug Free Work Environment. This project prohibits the use, possession, distribution or sale on its premises or workplace the following substances: alcoholic beverages, intoxicants, drugs and related drug paraphernalia. Employees must not report to work while under the influence of any drug or alcoholic beverage. Any substance, including prescription drugs, that impairs mental or motor function must not be used while working at or on this project.(Because marijuana remains illegal under Federal Law, medical marijuana cards or prescriptions permitting their use will not be allowed.)
The cost of enforcing this policy shall be the responsibility of each employer of the effected employee.

13(c). Safety Representative. Each Contractor/Subcontractor shall have a designated Safety Representative available at the site assigned the responsibilities of managing all aspects of safety related to employees under their direct control. These duties may be performed by a Field Superintendent or Foreman having the required training, experience and qualifications listed below. These employees may have duties other than safety provided appropriate adherence to State, Local Laws, Ordinances, Codes, Regulations and these Safety Specifications are followed by personal under their direct control.

CONTRACTOR/Sub-Contractor Safety Representative must have the following minimum qualifications:

- The CSR/SSR shall have a minimum of 3 -5 years of qualified project safety experience on similar type construction projects.
- Evidence of completing the OSHA 10 or 30 Hour Construction Outreach Training or equivalent with the past 3 yrs.
- Current First Aid/CPR certification provided by The American National Red Cross or equivalent training.
- Ability to stop work in the event of a workplace hazard, until corrective action has been implemented.
- Understanding of Federal and/or State Safety and OCIP Safety Regulations
- Ability to conduct appropriate incident investigations.
- Ability to communicate with field personal and project staff on relevant Health and Safety items.

13(d). Orientation. One of the requirements of all contractors/subcontractors and their safety representative or designees is to ensure that a complete basic safety orientation is conducted for all their employees new to the site. A Project Orientation by CONTRACTOR is required before an employee can receive a project ID and enter the field. At a minimum, the orientation shall include:

- Employee safety requirements and policies.
- Site Specific Safety and Health rules.
- Permitting procedures, including work permits, excavation, confined space entry, lock-out, etc.
- Hazard communication.
- Emergency alarms and evacuation procedures.

All employees will complete and sign a Safety Orientation form supplied by CONTRACTOR. Upon successful the employee will receive a hard hat sticker with an identification number to be worn on the employees hard hat at all times while on the project.

13(e). Fall Protection. 100% Fall Protection shall be implemented by all trades for all fall exposures of six (6) feet or more. (Exception: Work from ladders and work around excavations, within Cal/OSHA specifications)

13(f). Excavation. Trenching or excavating activities must be under the supervision of a competent person at all times.

13(g). PPE

Employees must at all times wear an ANSI Z89.1 approved hard hat on the jobsite.

Employers must supply all personal protective equipment.

Safety glasses with permanently affixed side shields are required at all times. All safety glasses, goggles, and face shields must have the ANSI-Z87 approval.

Sturdy work boots are required at all times on the jobsite. Employees on the jobsite shall not wear tennis shoes, running shoes, casual street shoes, sandals or shoes made of other thin material.

At minimum a Class II High Visibility reflective vest or equivalent shall be worn at all times while on-site.

13(h). Hazard Communication. CONTRACTOR shall maintain a copy of all Material Safety Data Sheets, *and* a chemical inventory list, for all hazardous substances used at the jobsite by their firm, as well as for all hazardous substances used at the jobsite by all Subcontractors regardless of tier.

13(i). Return to Work Program. Each Employer should have a written Early Return to Work Program that should be implemented on this project.

13(j). Experience Modification Factor/Rating: In no instance shall a contractor or any listed subcontractor with an EMR of 1.25 or higher at time of bid, or in cases of non-listed subcontractors, at the time of subcontract execution, be permitted to work on the project. A bid submitted with prime contract or any listed subcontractor EMR's greater than 1.25 will be deemed non-responsive.

GC 5. DEFAULT/TERMINATION OF CONTRACT

A. Default

1. If the Contractor refuses or fails to prosecute the Work or any separable part thereof with such diligence as will ensure its completion within the time specified herein or any authorized extension thereof, or abandons the Work, or fails to perform the Work in a manner required by the Contract Documents and/or industry standards, or fails to complete such Work within such time as required under the Contract Documents, or seeks to assign the Contract, or, if the Contractor should be adjudged as bankrupt, or is otherwise deemed insolvent by the County based on good cause and is unable to proceed with the Work, or if the Contractor should make a general assignment for the benefit of creditors, or if a receiver should be appointed on account of insolvency, or if the Contractor files a petition to take advantage of any debtor's act, or should any subcontractor materially violate any of the provisions of the Contract Documents, or if the Contractor should persistently or repeatedly refuse or fail to provide the required project management, supervision, quality control, and/or supply enough properly skilled workers or proper materials to complete the

Work in the time specified, or if the Contractor should fail to make prompt payment to subcontractors for material or labor, or if the Contractor should persistently disregard laws, or instructions given by County, or if the Contractor otherwise substantially fails to fulfill its obligations under, or violates, the Contract Documents or any provision or term thereof, the Contractor shall be in breach of and default under the Contract. In such instance, the County may, in its sole discretion, after providing Contractor seven (7) days written notice, and without prejudice to any other remedy the County may have:

- a. Provide any such labor, equipment and/or materials required to perform the Work or designated portion of the Work or to correct any deficiencies or delays and deduct the cost from any money due or to become due Contractor, or if the money due or to become due to Contractor is not sufficient to cover such amount, the Contractor shall pay the difference immediately to the County upon demand; or
 - b. Terminate the Contract.
2. Upon receipt of the notice of termination of the Contract, the Surety shall immediately takeover and assume the control of and perform the Work as the successor to the Contractor and shall immediately assume all rights obligations and liabilities, including liquidated damages, that have accrued under the Contract. The Surety shall maintain the Project site and all of its safety controls. If the Surety fails to maintain the Project site, the County may correct unsafe conditions and charge the Surety for costs incurred. If the Surety assumes the Contractor's terminated Work, it shall take the Contractor's place in all respects for that part and shall be paid by County for all Work performed by it in accordance with the terms of the Contract Documents. If the Surety assumes the entire Contract, all money due the Contractor at the time of its default shall be payable to the Surety as the Work progresses, subject to the terms of the Contract Documents less all amounts due to County.
3. Within fifteen (15) working days of its receipt of the notice of termination of the Contract, the Surety shall provide to the County a written plan detailing the course of action it intends to take to remedy the default of the Contractor. The County will review and notify the Surety if the plan is satisfactory.
4. If the Surety fails to submit a satisfactory plan or to maintain progress on the plan as accepted by the County, or does not otherwise comply fully and completely to the County's satisfaction with the terms of the Performance Bond within the time periods stated therein, the County may, in its sole discretion, take over the Work and prosecute the same to completion by contract or by any other method it may deem advisable for the account and at the expense of the Contractor, and the Surety and/or Contractor shall be liable to the County for any excess cost and all other damages and costs incurred by the County thereby or to which the County is entitled under the Contract Documents or by law and shall pay the County all such amounts within thirty (30) days after submits an invoice for such amounts. . In such an event, the County may without liability for so doing, take possession of and utilize such materials, tools, equipment, supplies and other property belonging to the Contractor and/or assume assignment of any and all subcontracts for subcontractors and/or suppliers that may be on the worksite and be necessary to complete the Work. For any portion of such Work that County elects to complete by furnishing its own employees, materials, tools, and equipment, the Contractor and Surety shall compensate County or all costs related thereto. If requested by County, Contractor shall demobilize, and shall remove any part or all of Contractor's materials, supplies, equipment, tools, and construction equipment and machinery, from the Project site within 7 days of such request; and if Contractor fails to do so, County may remove or store, and after 90 days sell, any of the same at Contractor's expense.
5. If a termination for default is asserted by County, and demand made upon Surety by County, Surety shall not tender the Contractor, or any affiliate thereof, as its completion contractor except as authorized in the Performance Bond and subject to the sole discretion of the County. See the Performance Bond for more details on the rights and responsibilities of the Surety.

6. Contractor hereby consents to assigning to the County and/or County's replacement contractor all subcontracts and other agreements of any and all subcontractors and/or suppliers that may be on the worksite and/or may be necessary to complete the Work in the event of Termination for Default or Termination for Convenience, as set forth below. Contractor agrees to obtain, by way of a subcontract provision, the consent of each and every subcontractor and/or supplier for such assignment prior to the commencement of each such subcontractor's and/or supplier's conduct of the Work.
7. In the event of such termination, the Contractor will not be entitled to receive any further payment until the entire Work or disputed portion of the Work is completed and accepted by the County. Any amounts due to Contractor will be based on unit prices or lump sum bid and the quantity of Work completed at the time of termination, less damages caused to the County by acts of the Contractor causing the termination, including but not limited to, all costs to the County arising from professional services and attorneys' fees, and all costs generated to insure or bond the work of substituted Contractors or subcontractors utilized to complete the Work, such excess shall be paid to the Contractor. If such costs exceed the unpaid balance, the Contractor shall pay the difference to the County promptly upon demand. On failure of the Contractor to pay, the Surety shall pay on demand by County. Any portion of such difference not paid by the Contractor or Surety within thirty (30) days following the mailing of a demand for such costs shall earn interest at the maximum rate authorized by California law. Nothing set forth herein shall limit Surety's obligations under the subject bonds or the timing thereof, which shall arise immediately upon Contractor's default.
8. The Contractor and the County agree that nothing in this section is intended to create a right of either party to recover attorney fees as prevailing party in any lawsuit on this Contract.
9. In addition to all of its rights and remedies stated herein and under the Contract Documents and by law, the County may also order the Contractor to stop the Work, or any portion thereof, until the cause for such order has been eliminated; however, this right of the County to stop the Work shall not give rise to any duty on the part of the County to exercise this right for the benefit of the Contractor or any other person or entity
10. The foregoing provisions are in addition to and not in limitation of any other rights or remedies under law or in equity available to County.
11. If it is later determined that the County's termination of the Contract was wrongful, or Contractor had an excusable reason for not performing, such as a fire, flood, or other event which was not the fault of or was beyond the control of the Contractor, the County, after setting up a new performance schedule, may allow the Contractor to continue work, or treat the termination as a termination for convenience, and the rights and obligations of the County and the Contractor shall be the same as if the termination had been issued for the convenience of the County.
12. Each of these general conditions, whether preceding or following this paragraph, is to be considered material and failure to comply with any of such conditions by the Contractor will be deemed a breach of contract. All obligations of Contractor pursuant to the Contract Documents shall survive the termination of the Contract.

B. Termination for Convenience

1. The County may terminate the Contractor's performance under the Contract, either in whole or in part, at its own discretion or when conditions encountered during the Work make it impossible or impracticable to proceed, or when the County is prevented from proceeding with the Contract by act of God, by law, or by official action of a public authority, or upon a determination that such termination is in the best interest and convenience of the County, or whenever the County is prohibited from completing the Work for any reason.
2. Upon receipt of such written notice of termination, the Contractor shall:
 - a. Stop work as specified in the written notice;

- b. Terminate all orders and subcontractors except as necessary to complete any portion of the Work that is not terminated;
 - c. If directed in writing by the County to do so, assign all right, title and interest in subcontracts and materials in progress, in which case the County will have the right at its discretion to settle, or pay any or all claims arising out of the termination of such subcontractors, but in no event shall recovery by any Contractor include lost profits for uncompleted portions of the Work;
 - d. Deliver or otherwise make available to the County all data, drawings, specifications, reports, estimates, summaries and such other information and material as may have been accumulated by the Contractor in performing the Work whether completed or in process;
 - e. Settle outstanding liabilities and claims with the approval of County;
 - f. Complete performance of such part of the Work as has not been terminated; and
 - g. Take such other actions as may be necessary, or as may be directed by the County for the protection and preservation of the Work and/or property related to the Work.
3. Upon receipt of County's written notice of termination for convenience, the Contractor shall submit to the County a request for final payment in accordance with the requirements of the Contract. Such request shall be submitted promptly, but no later than sixty (60) days from the effective date of the termination for convenience.
 4. The final payment to the Contractor after termination for convenience shall be limited to the following amounts due and owing under the Contract at time of termination:
 - a. Any actual costs incurred by the Contractor for restocking charges;
 - b. The agreed upon price of protecting the Work in any manner, if any, as directed by the County; and
 - c. The Contract Price allocable to the portion of the Work properly performed or goods supplied by the Contractor as of the date of termination, as determined in accordance with the Contract Documents, reduced by any sums previously paid to the Contractor.

Contractor shall not be entitled to payment for any Work not performed, including, without limitation, overhead and profit on Work not performed.

The above payment shall be the sole and exclusive remedy to which Contractor is entitled in the event of a termination for convenience of the Contract pursuant to this section; and Contractor will not be entitled to any other compensation or damages and expressly waives same.

5. The County shall have the right to withhold any portion or the whole of the final payment under this provision in the event there are any outstanding Claims for compensation asserted by the County against the Contractor, or by any third party against the County which arises out of the Contractor's Work.
6. All obligations of Contractor pursuant to the Contract Documents shall survive the termination for convenience of the Contract.
7. Contractor shall include this Termination for Convenience provision in all subcontracts and purchase orders of every tier.

GC 6. INDEMNIFICATION

- A. To the fullest extent permitted by law, the Contractor shall indemnify, defend and hold harmless the County and its Board Members, officers and officials, Owner's Representative, Construction

Administrator, Project Inspector, and the Architect and their agents and employees (the "Indemnified Parties") from and against any and all claims, damages, liabilities, actions, losses and expenses, including but not limited to attorneys' fees, in law and in equity, of every kind or nature whatsoever related to, arising out of or resulting from the performance of the Work or Contractor's operations to be performed under the Contract Documents, regardless of whether or not caused in whole or in part by a party indemnified hereunder (collectively "Claims"); excepting only such Claims arising from the sole or active negligence or willful misconduct of the Indemnified Parties or defects in design furnished by those persons. Such obligation shall not be construed to negate, abridge, or otherwise reduce any other right or obligation of indemnity which would otherwise exist as to any party or person described in this paragraph. The obligations in this section shall not be limited by the insurance requirements set forth in these Contract Documents. Contractor's indemnification obligations shall apply to all damages or claims for damages suffered as a result of or by Contractor's operations regardless if any insurance is applicable or not.

It is intended that this section shall comply with California Civil Code § 2782, *et seq.*, to the extent applicable to the Contractor's obligations as set forth in this section. If it is determined by a Court of competent jurisdiction that any aspect of this section exceeds the restrictions or limitations under California law applicable to indemnity obligations, only that portion which exceeds the restrictions or limitations under California law shall be null and void, and all remaining indemnity obligations shall be fully enforceable to the fullest extent allowed under California law.

- B. In any and all Claims against the Indemnified Parties by any employee of the Contractor, any subcontractor, anyone directly or indirectly employed by any of them or anyone for whose acts any of them may be liable, the indemnification obligation under this paragraph shall not be limited in any way by any limitation on the amount or type of damages, compensation or benefits payable by or for the Contractor or any subcontractor under Workers' or Workmen's Compensation Acts, disability benefit acts or other employee benefit acts.
- C. The right to a defense and indemnity under this section arises upon an occurrence of an event given rising to a Claim and upon tender to Contractor, Contractor shall defend the Indemnified Parties with counsel reasonably acceptable to the County. Notwithstanding the foregoing, the County shall be entitled, on its own behalf, and at the expense of the Contractor, to assume control of its defense or the defense of any Indemnified Party in any legal proceeding, with counsel reasonably selected by it. Should the County elect initially to assume control of its defense, or the defense of any Indemnified Party, it does so without prejudice to its right subsequently to request that Contractor thereafter assume control of the defense and pay all attorney's fees and costs incurred thereby.

GC 7. ASSIGNMENT OF CONTRACT

- A. The Contractor shall not assign or sublet the Contract in whole or in part without the prior written consent of the Owner. The Contractor shall not assign any monies due or to become due to it under the Contract without the prior written consent of the Owner.
- B. Any assignments permitted under these documents or approved by the Owner shall, in addition, have prior written approval of all sureties of the Contractor executing bonds or insurance in the interest of this Contract.
- C. If the Contractor seeks to assign any portions or monies as permitted, Contractor shall pay to the Owner \$1,000 to cover Owner's costs each time an assignment occurs.

GC 8. SEPARATE CONTRACTS

- A. The Owner reserves the right to let other contracts in connection with this Project. The Contractor shall afford all other such contractors reasonable opportunity for storage of their materials; shall provide that the execution of their work properly connects and coordinates with theirs; and shall cooperate with them to the end of facilitating the Work.

- B. The work performed or executed under other contracts in advance of work under this Contract shall be inspected and determined to be in proper condition by the Contractor before permitting related or connecting work to proceed under this Contract.
- C. Contractor shall immediately notify Architect, Owner's Representative, and Project Inspector through the Construction Administrator of any discrepancies, defects or other conditions found unsuitable for proper execution of the Work.

GC 9. CONFERENCES

- A. At any time during the progress of the Work, the Owner, Construction Administrator, Owner's Representative, or Architect shall have authority to require the Contractor to attend a conference of any or all of the contractors engaged in the Work; and any notice of such conference shall be duly observed and complied with by the Contractor.

GC 10. TERMS OF PAYMENT

- A. Within thirty (30) calendar days after the award of the Agreement, and before submission of the first application for payment, the Contractor shall submit to the County for approval a Schedule of Values allocated to the various portions of the Work, prepared in such form and supported by such data to substantiate its accuracy as the County may require. This schedule, unless objected to by the County, shall be used only as a basis for the Contractor's Applications for Payment. This Schedule of Values shall be so arranged that the value of the Work as it progresses may be readily determined. Payment for change order work will be made if the change order work is complete and is approved prior to the Owner's Representative issuing the monthly certification of payment. The total sum of the Schedule of Values shall equal the Contract Price.
- B. The Contractor shall, on or before the first day of each month, make an estimate of the work performed during the preceding month and submit an itemized application for payment, supported by such data substantiating the Contractor's right to payment as the County may require, including appropriate monthly updates to the construction progress schedule, and reflecting retention, if any, as provided elsewhere in the Contract Documents. Absent an express finding pursuant to Public Contract Code section 7201(b) authorizing the County to withhold a higher amount of retention (in excess of 5% of the estimated value of the work done and the labor, materials, equipment, and services provided), the County shall retain an amount from each progress payment not to exceed 5% of the estimated value of the work done and the labor, materials, equipment, and services provided, all in accordance with Public Contract Code section 7201, and the County shall pay to the Contractor ninety percent (95%) of the value of said work in place, as checked and approved, within thirty (30) calendar days of the County's receipt of an undisputed and properly submitted application for payment. The balance of five percent (5%) of the estimate shall be retained by the County until the time of final acceptance of the Work, and release in accordance with requirements of the Contract Documents and California law. In lieu of the five percent (5%) retainage, the Contractor may substitute securities as provided for in Public Contract Code Section 22300.
- C. As a condition precedent to payment by County, each itemized application for payment shall be accompanied by a current Conditional Waiver and Release On Progress Payment, in the form specified by the applicable California Civil Code, from Contractor and each of Contractor's subcontractors, suppliers, and union trust funds for which payment is sought by the application for payment, and an Unconditional Waiver and Release On Progress Payment, in the form specified by the applicable California Civil Code, from Contractor and each of Contractor's subcontractors, suppliers, and any union trust fund for which payment was sought by Contractor in the immediately preceding application for payment and for which the County made payment.
- D. The Contractor warrants that title to all work, materials and equipment covered by an application for payment will pass to the County, or its assignee, either by incorporation in the construction or upon receipt of payment by the Contractor, whichever occurs first, free and clear of all liens, stop notices, claims, security interest or encumbrances hereinafter referred to in this section as "liens"; and that no work, materials or equipment covered by an application for payment will have been

acquired by the Contractor, or by any other person performing work at the Project or furnishing materials and equipment for the Project, subject to an agreement under which an interest or an encumbrance is retained by the seller or otherwise imposed by the Contractor or such other person.

- E. Unless otherwise provided in the Contract Documents, payments may be made, within the sole discretion of the County, on account of materials or equipment not incorporated in the Work but delivered and suitably stored at the Project site and, if approved in advance by the County, payments may similarly be made for materials or equipment suitably stored at some other location agreed upon in writing. Applications for payment must differentiate between materials stored on site and materials stored off site. Payments for materials or equipment stored on or off the Project site shall be allowed only at the sole discretion of the County and shall be conditioned upon submission by the Contractor of a detailed description of all such materials and equipment and of bills of sale or such other procedures satisfactory to the County to establish the County's title to such materials or equipment or otherwise protect the County's interest, including applicable insurance and transportation to the Project site for those materials and equipment stored off the Project site. In addition, as a further condition precedent to payment for stored materials, Contractor shall:
1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment, for stored materials.
 2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
 3. Provide summary documentation for stored materials indicating the following:
 - a. Value of materials previously stored and remaining stored as of date of previous applications for payment.
 - b. Value of previously stored materials put in place after date of previous application for payment and on or before date of current application for payment.
 - c. Value of materials stored since date of previous application for payment and remaining stored as of date of current application for payment.

Contractor must complete specific considerations and comply with the requirements of the Contract Documents before purchasing any materials ahead of their scheduled installation. While there are clearly recognized benefits to both the Owner and Contractor for purchasing materials early, there is also increased risk and additional work required to protect those purchases and track them appropriately. It is Contractor's responsibility for the risk management of stored items and security that includes warranty protections. Purchasing of items must be approved by Owner's Representative prior to ordering materials to be delivered.

The County will only consider ahead-of-schedule material purchases under the following conditions:

1. Contractor provides supporting documentation (narrative) demonstrating valid reason or cause (such as long lead time, material or manufacturing shortages, tariffs, etc.)
2. Approved items have been inventoried by the Construction Administrator or Owner's Representative
3. Materials are stored in a safe and weather protected manner
4. Stored materials will be available for periodic inspections by Construction Administrator or Owner's Representative
 - a. If inspection is requested by County, Contractor shall reimburse Owner's Representative, Construction Administrator or Project Inspector for transportation, per diem and wages if out-of-town travel is required to reach storage location for inspection.
5. Stored materials have a required jobsite availability date clearly established in the project construction schedule.

The County will not consider payment for stored materials that are:

1. Not itemized
2. Raw materials or any items that are not ready for immediate installation at jobsite
3. Items that are not documented in the construction schedule

4. Items that are greater than 10% of the overall contract or 15% of current progress payment
5. Long lead items greater than 8 weeks

Additional requirements for stored materials:

1. Requests for storing materials offsite must be made at least 14 days prior to submission of pay application
2. Only bonded subcontractors and vendors will be considered for storage. Bonded subcontractors and vendors must show bonding documents that show County as assignee
3. Materials stored, but not requesting payment must be stored in a bonded facility unless in transit
4. Materials stored at the manufacturing facility will not be paid in advance unless it can be proven to be physically segregated from the rest of the facility. Materials stored at the manufacturing facility must be labeled with job identification, fenced off, shrink-wrapped or otherwise securely separated from regular inventory, to County's satisfaction.
5. Access and delivery of goods must be able to be cleared for release by Contractor in the event of a subcontractor/vendor failure to perform or replacement
6. Manufacturer warranty periods must be extended for the full duration that the materials are in storage

Contractor will keep an inventory log of stored materials offsite as well as onsite (yet to be installed) and submit with each upcoming progress payment funding request.

The inventory log must include the following:

- Description – that includes storage disposition and subcontractor/vendor responsibility information
- Onsite Previously Billed – quantities and values
- Onsite Previously Billed Now in Place – quantities and values
- Onsite Billed This Period – quantities and values
- Offsite Previously Billed – quantities and values
- Offsite Previously Billed Now in Place – quantities and values
- Offsite Billed This Period – quantities and values
- Total Currently Stored Onsite – values
- Total Currently Stored Offsite - values

Supporting documents to be submitted for approval fourteen (14) days prior to approval

- Subcontractor/vendor provides copies of insurance/bonding certification documents for storage location during the time of storage and naming the County as additional insured
- Subcontractor/vendor provides evidence of insurance coverage during transportation of stored materials and naming the County as additional insured
- Subcontractor/vendor provides letter accepting responsibility for any deductibles placed on those specific stored materials
- Copies of invoices/bill of sale
- Copy of log stored materials with updated disposition of materials stored status that includes locations, bonding information, dates of insurance certificate coverage periods, etc.
- Photographic evidence of stored materials in the conditions in which they are stored and with identifiable markings on them indicating invoice/bill of sale relationship. Packing slips do not contain enough information to identify specific materials with job orders
- Evidentiary photos must be labeled with a description of the materials and the date pictures were taken.

- F. Acceptance of any work and payments therefore shall be made upon written recommendation of the Owner's Representative and Architect.
- G. Payments to the Contractor will be made within 30 days of receipt of an undisputed and properly submitted application for payment in accordance with Owner's regular approval and accounting procedures, based upon statements or certificates received as issued or approved by the Owner's

Representative, including written certification that complete certified payroll records have been, or will be, submitted to the Labor Commissioner as required by the California Labor Code.

- H. The Contractor shall promptly pay each subcontractor upon receipt of payment from the County, out of the amount paid to the Contractor on account of such subcontractor's work, the amount to which subcontractor is entitled, reflecting the percentage actually retained, if any, from payments to the Contractor on account of such subcontractor's work. The Contractor shall, by an appropriate written agreement with each subcontractor, require each subcontractor to make payments to their sub-subcontractors in similar manner.
- I. Neither certification of a progress payment, delivery of a progress payment, nor partial or entire use or occupancy of the Project by the County, shall constitute an acceptance of any work not in accordance with the Contract Documents, nor shall it be deemed a waiver of County of any remedy it may have in law or equity.
- J. The County may withhold any payment in whole or in part to the extent necessary to reasonably protect the County, if it is unable to verify the accuracy of an application for payment. If the County is unable to verify the accuracy of an application for payment, the County will notify the Contractor in writing. If the Contractor and the County cannot agree on a revised amount, the County will promptly process payment for those amounts for which it is able to verify. The County may also withhold any payment, or portion thereof, to protect the County from loss because of subsequently discovered:
- (i) Defective work not remedied;
 - (ii) Third party claims filed or reasonable evidence indicating probable filing of such claims, including claims by separate contractors;
 - (iii) Failure of the Contractor to make payments properly to subcontractors, or for labor, materials or equipment;
 - (iv) Reasonable evidence that the Work cannot be completed for the unpaid balance of the Contract Price;
 - (v) Damage to the County or another contractor;
 - (vi) Reasonable evidence that the Work will not be accomplished in compliance with the Contract Time;
 - (vii) Failure to carry out the Work in accordance with the Contract Documents, including, without limitation, the failure to make required submittals;
 - (viii) Stop notice(s) served upon the County;
 - (ix) Failure to submit certified weekly payrolls;
 - (x) Failure or refusal of Contractor to comply with the Contract Documents, including the failure of the Contractor to provide any required warranty/maintenance bond; and
 - (xi) Any other material breach of the Contract Documents by Contractor and/or its subcontractors or suppliers of any tier.

When the grounds above are removed, payment shall be made by County for amounts withheld because of them within 30 days thereafter.

Should Stop Notices be filed with the Owner, Owner shall in accordance with California Civil Code Section 9358, withhold the amount claimed, plus an allowance of 25% to cover its litigation costs

plus interest at the rate of 10%, from certificates until such claims have been resolved pursuant to law.

- K. Subject to and in accordance with the requirements of California law (including Public Contract Code section 7201) and the Contract Documents, the County shall hold retainage from the Contractor. The Contractor, or its subcontractors, shall return all monies withheld in retention from a subcontractor within the time periods authorized under California law after receiving payment for work satisfactorily completed and accepted including incremental acceptances of portions of the contract work. Any violation of this provision shall subject Contractor, or its subcontractors, to the penalties, sanctions and other remedies specified under California law. These requirements shall not be construed to limit or impair any contractual, administrative, or judicial remedies otherwise available to County or the Contractor, or its subcontractors, in the event of a dispute involving late payment or nonpayment by Contractor, deficient subcontract performance, or noncompliance by a subcontractor. This provision applies to both DBE and non-DBE contractors and subcontractors.

Pursuant to Section 22300 of the California Public Contract Code, the Contractor may elect to substitute securities for any monies withheld by the County to ensure performance under the Contract Documents. At the request and expense of the Contractor, securities equivalent to the amount withheld shall be deposited with the County, or with a state or federally chartered bank as the escrow agent, who shall then pay such monies to the Contractor. Upon satisfactory completion of the requirements of the Contract Documents, the securities will be returned to the Contractor. Such securities, if deposited by the Contractor, shall be valued by the County, whose decision on valuation of the securities shall be final. Securities eligible for investment under this provision shall be limited to those listed in Section 22300 of the Public Contract Code.

- L. Contractor, and its subcontractors, shall pay any subcontractor not later than seven (7) calendar days of receipt of each progress payment in accordance with the provision in section 7108.5 of the California Business and Professions Code concerning prompt payment to subcontractors. Any violation of section 7108.5 shall subject the violating contractor or subcontractor to the penalties, sanction and other remedies of that section. This requirement shall not be construed to limit or impair any contractual, administrative, or judicial remedies otherwise available to County or the Contractor, or its subcontractors, in the event of a dispute involving late payment or nonpayment by the Contractor, deficient subcontract performance, or noncompliance by a subcontractor. This provision applies to both DBE and non-DBE subcontractors.

- M. When the Work is ready for acceptance by the County, the Owner's Representative will confirm whether the Work has reached Substantial Completion and will prepare a list of items to be complete or corrected. The failure to include any item on such list does not alter the responsibility of the Contractor to complete all Work in accordance with the Contract Documents.

- N. Upon final completion of all work and Final Acceptance by the Board of Supervisors, with the contract requirements having been fully and completely satisfied including, without limitation:
1. Acceptance of the work by the Owner's Representative and Architect
 2. The Contractor providing to the County all documents and information required by the Contract Documents including, without limitation:
 - a. All releases
 - b. Maintenance guarantees
 - c. Maintenance manuals and technical specifications
 - d. All requirements for Contract Closeout including as set forth Section 01 77 00 herein

And Thirty-five (35) days after recordation by the County of a Notice of Completion with the County Recorder following Board of Supervisor's Acceptance:

1. All claims for labor and materials have been paid
2. No claims shall have been filed with the County based upon acts or omissions of the Contractor
3. No stop notices have been filed

The Contractor shall be entitled to the balance due for the completion and acceptance of the Work, less sums withheld for liquidated damages, if any, or any other damages incurred by the

County or other sums withheld pursuant to the terms of the Contract Documents or by law.

- O. The making of final payment shall not constitute a waiver of any claims by the County.
- P. Subject to the terms of the Contract Documents, the acceptance of final payment shall, after the date of Substantial Completion of the Project, constitute a waiver of all Claims by the Contractor.
- Q. All provisions of this Agreement, including without limitation those establishing obligations and procedures, shall remain in full force and effect notwithstanding the making or acceptance of final payment.
- R. Final payment will be made in accordance with the Contract Documents and California law, including, without limitation, Public Contract Code § 7107.
- S. Pursuant to Public Contract Code § 7107, in the event of a dispute between the County and Contractor, the County may withhold from the final payment an amount not to exceed 150 percent of the disputed amount.

GC 11. CONFLICTS OR ERRORS

- A. During construction, if any conflicts are discovered in the Plans or Specifications, they shall be immediately submitted to the Owner's Representative who will render an interpretation on what was intended and the Contractor agrees to furnish all things necessary by such interpretation to the satisfaction of the Owner's Representative without additional expense to the Owner.
- B. The Contractor shall not contend that any error, delay or default in its work is due to omission or ambiguity in said plans or specifications.
- C. If errors are found in the Contract Documents that cannot be termed conflicts, the Contractor shall immediately notify the Owner's Representative no later than 10 calendar days following the discovery of any such error.
- D. Refer to G.C. 24, Unity of Documents.

GC 12. CHANGES IN THE WORK

- A. No modification or deviation from Plans and Specifications will be permitted by the Contractor without prior written consent of Owner. However, Owner, without invalidating the Contract, and with or without notice to Contractor's surety, may order extra work or make changes by altering, adding to, or deducting from the Work, Changes in the work may be accomplished after execution of the Contract, and without invalidating the Contract, by Change Order or Field Order subject to the limitations stated herein.
- B. A Change Order shall be based upon agreement between the Owner and Contractor; a Field Order may or may not be agreed to by the Contractor.

Changes in the work shall be performed under applicable provisions of the Contract Documents, and the Contractor shall proceed promptly, unless otherwise provided in the Change Order or Field Order. Contractor agrees that any claims for extra costs for equipment shall be determined by the rates set forth in the California Department of Transportation's equipment rental rate book. Contractor shall provide notice and documentation of such daily equipment costs together with daily time and material tags within seven (7) days of incurring such costs under a Field Order. Contractor's failure to comply with the requirements of this section shall constitute a waiver of any extra equipment cost claims.

- C. The credit to or charge against the Owner shall be determined as follows:

1. In the event that a modification results in a reduction of the amount of labor and material to be supplied by the Contractor, the Owner shall be given a credit equal to the actual value of such labor and materials plus a reasonable amount for the use of tools, materials and reasonable overhead and profit as set forth below;
2. In the event a modification results in an increase in the amount of labor and materials to be supplied by the Contractor, the Owner shall pay the Contractor the actual value of such labor, materials and equipment plus reasonable overhead and profit as set forth below. All costs shall be included as a lump sum price on change orders.
3. The Contractor agrees that its reasonable overhead and profit on modifications to the work shall not exceed the values in the following table:
 - a. Allowances for overhead and profit as shown in table below shall include full compensation for any and all items of overhead including, but not limited to, overhead, profit, bonds, insurance, superintendence, layout, field engineering, and any related work not included in the actual cost of labor and materials.
 - b. Backup documents and a breakdown showing raw costs and markups shall be provided as a part of the Cost Proposal.

Overhead and Profit Markup for Modifications to Work		
Modified Raw Cost of Materials and Labor	Work is Self-performed by General Contractor (GC)	Work is Subcontracted
\$0 - \$5,000	20% to GC	20% to Subcontractor 5% to GC
\$5,001 - \$20,000	15% to GC	15% to Subcontractor 5% to GC
\$20,000 - \$40,000	12% to GC	12% to Subcontractor 5% to GC
\$40,001 - up	10% to GC	10% to Subcontractor 5% to GC

4. Cost Proposals for all changes shall be submitted by the Contractor to the Construction Administrator for review by the Owner's Representative and Architect. The Contractor shall submit all Cost Proposals within 15 calendar days following the discovery of any potential change. The Owner's Representative shall render a written decision as to reasonable costs within 15 calendar days of receiving cost proposal unless more time is agreed to by both Contractor and Owner's Representative.
 5. Any increases in cost or extension of time shall be approved by the Owner's Representative, Architect and Owner, on a signed change order.
 6. In the event that the Contractor, for whatever reason, does not accept the dollar amount of increase or decrease or extension of time to the contract amount in the decisions rendered by the Owner, Contractor shall, upon receiving written Field Order from the Owner, proceed with the work called for in the Cost Proposal on a time and materials basis using detailed daily reporting of labor, materials and profit & overhead. Any claim for dollar increases or extension of time shall be made in writing to the Owner's Representative in accordance with the provisions of GC 51, Claims Procedures.
- D. In response to a request for a proposed modification, Contractor shall promptly furnish within 15 calendar days, relevant cost breakdowns, time estimates and other information as may be required to the Owner's Representative.
- E. A Change Order is a written instrument prepared by the Owner's Representative, recommended by the Architect and signed by the Owner and Contractor stating their agreement upon all of the following:
1. The change in the work;
 2. The amount of the adjustment, if any, in the Contract Price; and
 3. The extent of the adjustment, if any, in the Contract Time.

Eliminated Items - The Owner reserves the right to eliminate any contract item of work prior to the award of the Agreement without incurring any obligation to pay therefor. Should any contract item of the Work be eliminated in its entirety following the award of the Agreement and in the absence of an executed Change Order covering such elimination, payment will be made to the Contractor for reasonable costs actually incurred, and which are validated by Owner as being incurred, in connection with such eliminated contract item if incurred prior to the date of notification in writing by the Owner of such elimination.

An executed Change Order shall constitute a final settlement of all matters relating to the change in the work which is the subject of the Change Order, including, but not limited to, all direct and indirect costs associated with such change, any adjustments to the Contract Price, and any and all adjustments to the Schedule or Contract Time.

- F. A Field Order is a written order prepared by the Owner's Representative and signed by the Owner, directing a change in the work prior to agreement on adjustment, if any, in the Contract Price or Contract Time, or both. The Owner may by Field Order, without invalidating the Contract, order changes in the work within the general scope of the Contract consisting of additions, deletions or other revisions, the Contract Price and Contract Time being adjusted accordingly.

To the extent Owner refuses to issue a change order for such work or the Owner and Contractor cannot agree on the cost or credit or time for the changed work, Contractor shall nevertheless perform that work as expeditiously and timely as possible and shall submit a complete and specific claim for additional compensation or extension of the time for performance within ten (10) days after such work is performed. For each day any extra work is performed, Contractor shall identify the same in the daily report in a format as required by Owner, and Contractor shall complete, sign and deliver to Owner a specific daily extra work form detailing the actual extra work performed. Contractor's failure to provide written notice of claim prior to undertaking such work, or failure to submit timely the daily report, the daily extra work report, and a complete and specific claim for additional compensation or extension of the time for performance, shall be deemed a waiver and abandonment of any such claim. No claim, dispute or controversy shall interfere with the progress or performance of the work.

- G. A Field Order shall be used in the absence of total agreement on the terms of a Change Order.

If the Field Order provides for an adjustment to the Contract Price, the adjustment shall be based on one of the following methods:

1. Mutual acceptance of a lump sum properly itemized and supported by sufficient substantiating data to permit evaluation;
2. Unit prices stated in the Contract Documents or subsequently agreed upon;
3. Cost to be determined in a manner agreed upon by the Owner and Contractor and a mutually acceptable fixed or percentage fee; or
4. As provided in Subsection I below.

- H. A Field Order signed by the Contractor indicates the Contractor's agreement therewith, including adjustment in Contract Price and Contract Time or the method for determining them. Such agreement shall be effective immediately and shall be recorded as a Change Order.

- I. If the Contractor does not respond promptly or disagrees with the method for adjustment in the Contract Price, the Owner's Representative shall determine the method and the adjustment on the basis of reasonable expenditures and savings of those performing the work attributable to the change, including, in case of an increase in the Contract Price, an amount for overhead and profit as set forth in the Agreement, or if no such amount is set forth in the Agreement, a reasonable amount. In such case, and also under Subsection G above, the Contractor shall keep and present, in such form as the Owner's Representative may prescribe, an itemized accounting together with appropriate supporting data. Unless otherwise provided in the Contract Documents, costs for the purposes of this section shall be limited to the following:

1. Costs of labor, including social security, old age and unemployment insurance, fringe benefits required by agreement or custom, and workers' compensation insurance;
 2. Costs of materials, supplies and equipment, including cost of transportation, whether incorporated or consumed;
 3. Rental costs of machinery and equipment, exclusive of hand tools, whether rented from the Contractor or others;
 4. Costs of premiums for all bonds and insurance, permit fees, and sales, use or similar taxes related to the work; and
 5. Additional costs of supervision and field office personnel directly attributable to the change.
- J. The amount of credit to be allowed by the Contractor to the Owner for a deletion or change that results in a net decrease in the Contract Price shall be actual net cost as calculated in paragraph C above and confirmed by the Owner's Representative. When both additions and credits covering related work or substitutions are involved in a change, the allowance for overhead and profit shall be figured on the basis of net increase, if any, with respect to that change.
- K. Pending final determination of the total cost of a Field Order to the Owner, the Contractor may request payment for work completed under the Field Order in Applications for Payment. The Owner's Representative will make an interim determination for purposes of monthly certification for payment for those costs and certify for payment the amount that the Owner's Representative determines, in the Owner's Representative's professional judgment, to be reasonably justified. The Owner's Representative's interim determination of cost shall adjust the Contract Price on the same basis as a Change Order, subject to the right of either party to disagree and assert a Claim in accordance with Articles 15 and 51.
- L. When the Owner and Contractor agree with a determination made by the Owner's Representative concerning the adjustments in the Contract Price and Contract Time, or otherwise reach agreement upon the adjustments, such agreement shall be effective immediately and the Owner's Representative will prepare a Change Order. Change Orders may be issued for all or any part of a Field Order. Failure of the Contractor to notify the Owner of any disagreement with any proposed adjustment to the Contract Price, Schedule and/or Contract Time, as applicable, or method for determining them set forth in a Field Order within seven (7) days after the date of receipt by the Contractor of such Field Order shall be deemed to be an agreement by the Contractor to the proposed adjustment to the Contract Price, Schedule and/or adjustment to the Contract Time, as applicable, or method for determining them set forth in such Field Order, and shall constitute a waiver by Contractor of any claims related thereto.

GC 13. GUARANTEE

- A. The Contractor shall be held responsible to make-good any defects due to faulty, improper or inferior workmanship or materials arising or discovered in any part of the Work within one (1) year after the completion and final acceptance of the same by the Owner's Representative, Architect and Owner unless a longer period is called for in the Technical Specification Sections. Any and all guarantee periods, one year or otherwise, do not in any way limit or waive the County's rights to pursue legal action for patent or latent construction defects in accordance with California Code of Civil Procedure sections 337.1 and/or 337.15.
- B. In the event of failure of Contractor to comply with the requirements of any guarantee by this Contract, including without limitation the guarantee(s) provided by this section, within seven (7) days after being notified in writing, Owner is authorized to proceed to have the defects repaired and made good at the expense of Contractor, who shall pay the costs and charges therefore immediately on demand.
- C. Acceptance of the Work by the Owner's Representative, Architect or Owner shall in no way absolve the Contractor from the responsibility of complying with the provisions of the Plans and Specifications and other contract documents, even though deviations may not be discovered within the aforementioned one year period.

- D. The bond for faithful performance furnished by the Contractor shall cover such defects and protect the Owner against them and remain in force during the one year guarantee period.

GC 14. INTERPRETATIONS

- A. The Contractor shall comply with the obvious intent and meaning of the Plans and Specifications which shall be construed to include all material, measures and modes or work necessary to complete the work required in a workmanlike manner, in strict accordance with these Plans and Specifications, and to the satisfaction of the Owner.
- B. Should any question arise as to the intent and interpretation of the Plans or Specifications, the Contractor shall promptly, upon discovery thereof, refer the same in writing to the Owner's Representative, whose decision thereon shall be final.

GC 15. DECISIONS BY ARCHITECT AND/OR OWNER'S REPRESENTATIVE

- A. The Owner's Representative shall, in all cases, determine whether the amount and quality of the several kinds of work which are to be paid for under the Contract are in accordance with the Plans and Specifications.
- B. The Owner's Representative shall have power to cause all or any part of the Work to be expedited with greater diligence when delayed or stopped.
- C. When requested by the Owner's Representative, the Architect's decisions in matters relating to artistic effect will be final if consistent with the intent of the Contract Documents.
- D. Where not involving a change in the agreed Contract Price or Contract Time, and not inconsistent with the intent of the Contract Documents, the Owner's Representative shall have authority to:
1. Correct any errors or inconsistencies in, and make any deletions from or additions to the drawings and specifications;
 2. Order minor changes or adjustments in the work, whether by field order, notations on Contractor's submittals, or other instructions;
 3. Order certain portions of the work delayed when particularly involved with or affected by any Change Order in process or being considered by Owner.
- E. The Owner's Representative will be the interpreter of the requirements of the Contract Documents and the judge of the performance thereunder by both the Owner and Contractor.
- F. The Architect, when requested by the Owner's Representative, will render interpretations necessary for the proper execution or progress of the Work, with reasonable promptness and within fifteen (15) calendar days.
- G. Claims, disputes and other matters in question between the Contractor and the Owner relating to the execution or progress of the Work or the interpretation of the Contract Documents shall be referred to the Owner's Representative for decision which the Owner's Representative will render in writing with a reasonable promptness and within fifteen (15) calendar days. In the absence of a written decision by Owner's Representative, said claims, disputes and other matters shall be deemed denied or rejected.

GC 16. ADMINISTRATION OF THE CONTRACT

- A. The Construction Administrator will provide administration of the Contract. Maintenance of the Project records for the Contract shall be as prescribed by the Owner's Representative and as hereinafter described.
- B. The Owner's Representative will be the representative of the Owner during construction and until final payment is due. The Architect will advise and consult with the Owner's Representative and

- Owner. The Owner's instruction to the Contractor shall be forwarded through the Construction Administrator. The Construction Administrator will have authority to act on behalf of the Owner only to the extent provided in the Contract Documents, unless otherwise modified by written instrument.
- C. The Construction Administrator, Owner's Representative, Project Inspector or Architect will not be responsible for and will not have control or charge of construction means, methods, techniques, sequences or procedures, or for safety precautions and programs in connection with the Work, and will not be responsible for the Contractor's failure to carry out the Work in accordance with the Contract Documents. The Construction Administrator, Owner's Representative, Project Inspector or Architect will not be responsible for or have control over acts or omissions of the Contractor, subcontractors, or any of their agents or employees, or any other persons performing any of the Work.
- D. The Construction Administrator, Project Inspector, Owner's Representative and Architect shall at all times have access to the Work wherever it is in preparation and progress. The Contractor shall provide facilities for such access so the Construction Administrator, Project Inspector, Owner's Representative and Architect may perform their functions under the Contract Documents.
- E. Based on the Construction Administrator, Project Inspector, Owner's Representative and Architect's observations and an evaluation of the Contractor's applications for payment, the Owner's Representative will determine the amounts owing to the Contractor and will issue Certificates for Payment in such amounts as provided in GC Article 10.
- F. The Construction Administrator shall, upon receipt of a complete submittal from the Contractor, make the submission to the Architect. The Architect shall review and take appropriate action on shop drawings, product data, samples, and other submittals required by the Contract Documents. Such review shall be only for general conformance with the design concept and general compliance with the information given in the Contract Documents. It shall not include review of quantities, dimensions, weights or gauges, fabrication processes, construction methods, coordination with the work of other trades, or construction safety precautions, all of which are the sole responsibility of the Contractor. The Architect's review shall be conducted with reasonable promptness, and within 21 calendar days unless otherwise noted, consistent with sound professional practice. Review of a specific item shall not indicate acceptance of an assembly of which the item is a component. The Architect shall not be required to review and shall not be responsible for any deviations from the Contract Documents not clearly noted by the Contractor, nor shall the Architect be required to review partial submissions or those for which submissions for correlated items have not been received.
- G. The Owner's Representative will prepare Change Orders in accordance with GC Article 12.
- H. The Contractor shall provide sufficient, safe and proper facilities at all times for the full inspection of the Work by the Architect or other representatives of the Owner, at the Project site and at the various other locations where the Project is being performed.
- I. The Owner's Representative, Project Inspector and Architect will have authority to reject work which does not conform to the Contract Documents. Whenever, in their opinion, the Owner's Representative, Project Inspector and Architect considers it necessary or advisable for the implementation of the intent of the Contract Documents, the Owner's Representative, Project Inspector or Architect will have authority to require special inspection or testing of the Work in accordance with GC Article 31, whether or not such work be then fabricated, installed or completed. However, the Owner's Representative, Project Inspector and Architect's authority to act under this Subparagraph and any decision made by them in good faith to exercise or not to exercise such authority, shall not give rise to any duty or responsibility of the Owner's Representative, Project Inspector or Architect to the Contractor, and subcontractor, any of their agents or employees, or any other person performing any the Work.

J. The duties, responsibilities and limitations of authority of the Owner's Representative as the representative of the Owner during construction as set forth in the Contract Documents will not be modified or extended without written consent of the Owner.

GC 17. NON-CONFORMING WORK

A. The fact that the work and materials have been inspected from time to time and payments on account have been made, shall not relieve the Contractor from the responsibility of replacing and making good any defective work or materials that may be discovered after the date of completion of the Work by the Contractor and its approval by the Owner's Representative, Architect, and its acceptance by the Owner.

B. Failure of Owner's Representative, Architect or Owner to object to any defects in work or material or variances from the Plans and Specifications during or after construction shall not be deemed a waiver by Owner, Owner's Representative or Architect of such defects or variances; nor by such failure shall Owner, Owner's Representative or Architect be deemed stopped from requiring Contractor to correct such defects or variances.

C. At Owner's sole option, if Owner prefers to accept non-conforming work, Owner may do so instead of requiring its removal and correction, in which case a Change Order will be issued to reflect an appropriate reduction in the Contract Price, or if the amount is determined after final payment it shall be paid by the Contractor.

D. Uncovering of Work:

1. If any portion of the Work should be covered contrary to the request of the Owner's Representative, Project Inspector or Architect, or to requirements specifically expressed in the Contract Documents, it must, if required in writing by the Owner's Representative, be uncovered for their observation and shall be replaced at the Contractor's expense.

2. If any other portion of the Work has been covered which the Owner's Representative, Project Inspector or Architect has not specifically requested to observe prior to being covered, the Owner's Representative, Project Inspector or Architect may request to see such work and it shall be uncovered by the Contractor. If such work be found in accordance with the Contract Documents, the cost of uncovering and replacement shall, by appropriate Change Order, be charged to the Owner. If such work be found not in accordance with the Contract Documents, the Contractor shall pay such costs unless it be found that this condition was caused by the Owner or a separate contractor as provided in GC 8 above, in which event the Owner shall be responsible for the payment of such costs.

E. The County's rights as set forth in this section are without prejudice to any other right or remedy the County may have under the Contract Documents or by law, including without limitation, under GC 5.

GC 18. OWNERSHIP OF DOCUMENTS

A. All Plans and Specifications shall remain the property of the Owner and shall be returned to the Owner's Representative or shall be accounted for by the Contractor before the final acceptance of building by the Owner.

B. Documents for this Project shall not be used on or for any other work or purposes without express written consent of Owner's Representative, Architect and Owner.

GC 19. DOCUMENTS FURNISHED

A. If requested, the Contractor will be supplied five (5) sets of Contract Documents for use in the work.

B. Additional sets of Contract Documents may be obtained from the County, at cost, at Contractor's expense.

GC 20. DRAWING DIMENSIONS

- A. The general dimensions are shown in figures on the drawings furnished to the Contractor. These figured dimensions shall invariably have preference to scaled measurements; but the Contractor shall exercise proper caution and care to verify the figures before laying out the Work, and shall be held responsible for any omissions or errors therein that might have been avoided.

GC 21. DETAILED DRAWINGS

- A. Drawings and details may be furnished to the Contractor as work progresses, showing in more elaboration the work intended to be done and the Contractor shall conform to them as being a part of the Contract.
- B. No work shall be performed in advance of the receipt by the Contractor of such detailed drawings, except such work as the Owner's Representative shall order in writing to be done without details. Any complaint as to the character and extent of the details shall be made to the Owner's Representative within ten days after the Contractor has received the same. The Contractor shall notify the Owner's Representative in ample time as to when the Contractor will require these drawings so they may be prepared without causing any delay to the Work.

GC 22. SUBMITTALS

- A. Shop Drawings are drawings, diagrams, schedules, coordination drawings, setting drawings and other data specially prepared for the Work by the Contractor or any subcontractor, manufacturer, supplier or distributor to illustrate some portion of the Work.
- B. Product Data are illustrations, standard schedules, performance charts, instructions, brochures, diagrams and other information furnished by the Contractor to illustrate a material, product or system for some portion of the Work.
- C. Samples are physical examples which illustrate materials equipment or workmanship and establish standards by which the Work will be judged.
- D. The Contractor shall review, approve and submit, with such promptness as to cause no delay in its own work or in that of any other contractor, copies of all Shop Drawings, schedules for the work of the various trades and samples of materials and finishes required for the Work, together with information or supporting data as may be required or called for. The Owner's Representative will pass upon them with reasonable promptness in accordance with GC Article 16. The Contractor shall make any corrections required by the Owner's Representative or Architect and resubmit corrected copies to Owner's Representative or Architect for further review.
- E. Samples required or called for shall be exactly as specified for and intended to be used in the work; and Shop Drawings shall accurately portray the work required. Materials, finishes and workmanship shall be equal in every respect to that of the reviewed submittals.
- F. Submittals shall be delivered to, and as directed by, the Construction Administrator, postage or delivery charges prepaid by the Contractor in all cases. Samples returned upon request from the Contractor shall be returned by collect mail, parcel post or any carrier named by Contractor.
- G. The furnishing by the Contractor for the review by the Architect of drawings, samples, schedules or other data shall not relieve the Contractor from responsibility for deviations from drawings or specifications, nor shall it relieve it of responsibility for errors of any sort in shop drawings, schedules or other submittals.
- H. By approving and submitting Shop Drawings, Product Data and Samples, the Contractor represents that it has determined and verified all materials, field measurements, and field construction criteria related thereto, or will do so, and that it has checked and coordinated the

information contained within such submittals with the requirements of the Work and of the Contract Documents.

- I. Each Submittal shall be properly identified as required by the Construction Administrator.
- J. Deviations from requirements of Contract Documents, errors, inconsistencies with submittals previously made to or reviewed by Architect, and corrections to dimensions or supporting data shall be clearly identified by the Contractor by notations on the submittals or attached explanations.
- K. No portion of the Work requiring submission of a Shop Drawing, Product Data or Sample shall be commenced until the submittal has been reviewed by the Architect as provided in Subparagraph F of GC Article 16. All such portions of the Work shall be in accordance with reviewed submittals.

GC 23. SURVEY AND LAYOUT

- A. All work pertaining to this Contract shall be laid out on the premises by the Contractor who shall be held responsible for its correctness.
- B. The Contractor shall retain and pay for the services of a registered engineer or licensed surveyor, as required by the Plans and Specifications, or when applicable to ensure work is properly laid out, who shall lay out the main lines of the building and other improvements at the site and provide other primary lines, pile locations and levels as may be required.
- C. All stakes, benchmarks, survey marks, monuments and other line or level points which have been or may be established in the building or on or about the premises shall be carefully preserved and respected by the Contractor.
- D. On-site work shall be laid out to properly meet existing off-site work not required to be removed or replaced, or to lines and levels established by civil authorities having jurisdiction, as applicable to conditions at the place of the Work.

GC 24. UNITY OF DOCUMENTS

- A. The Plans and Specifications are one document and any work shown, required or called for in the one and not in the other, or vice versa, shall be furnished or performed as though it were shown, required or called for in both.
- B. The Contractor admits and agrees that the Contract Documents exhibit the intent and purpose of the Owner in regard to the Work, and that they are not complete in every detail and are to be considered as showing the purpose and intent only; and Contractor further agrees to furnish all labor or material for any detail that is necessary to carry out said intent and purpose without extra charge to the Owner.
- C. The misplacement, addition or omission of any word, letter or punctuation mark shall in no way change the intent, purpose of meaning or the Plans and Specifications.
- D. Any part of the Work or any article or detail pertaining thereto which is not specifically set forth in the Specifications or shown on the Drawings, but which is necessary for the proper completion of the Work, shall be furnished and installed at the Contractor's expense the same as if it had been partly or fully shown or specified. The Contractor shall do and furnish all things necessary to make a complete and workmanlike job in accordance with the intent and purpose of the Contract Documents.

GC 25. INSPECTION BY CONTRACTOR

- A. The Contractor shall inspect, review, compare and familiarize himself with the Contract Documents and the premises of the Work, and shall at once report to the Architect and Owner's Representative, in writing, any error, omission or inconsistency within the documents or between information given and conditions observed or found at the premises.
- B. The Contractor shall make a close inspection of all materials as delivered, and shall promptly return all damaged or defective materials without waiting for their rejection by the Owner's Representative, Project Inspector, or Architect.
- C. Before beginning any of the Work, the Contractor shall examine all construction and work of other contractors or trades that may affect this work, and to satisfy that everything is in proper condition to receive this work; and shall at once notify the Construction Administrator and Owner's Representative in writing of any exception taken to any construction or condition so affecting this work, whether placed under this Contract or other contracts.
- D. Failure to file with the Construction Administrator and Owner's Representative any notice to the contrary shall constitute acceptance by the Contractor of the construction of other contractors or trades as being suitable in all ways to receive its work, except as to defects which later develop in the work of other contractors after the execution of its own work.
- E. Contractor's inspection of documents and premises shall include making known to itself the general and particular location, nature and character of the Project work, the physical and contractual conditions, provisions and requirements, the nature and extent of work and equipment to be furnished by Owner, and the limitations and various other aspects relative to this Project, including all coordination necessary for proper and timely execution of the Work.
- F. Owner will not consider any claims whatsoever on account of Contractor's failure to fully investigate or determine the requirements of the Work in advance of commencing the Work or the conditions of the Work throughout its progress.

GC 26. DEVIATION FROM PLANS OR SPECIFICATIONS

- A. No deviations shall be made from the Plans or the Specifications. If the Contractor shall vary from the plans the amount or value of the materials herein provided for, the Owner shall have the right to order such improper work or materials removed or replaced; any other work disturbed or damaged by such alteration shall be made good at the Contractor's expense.

GC 27. STANDARDS OF MATERIALS

- A. Wherever the name or brand of a manufacturer's article is specified herein, it is used as a measure of quality and utility; a standard.
- B. If the Contractor desires to use any other brand or manufacturer of equal quality and utility to that specified, Contractor shall make application to the Owner's Representative in writing, and submit samples if requested. Refer to Section 00 21 13, "Instructions To Bidders" for substitution request procedures.

GC 28. QUALITY OF MATERIALS AND LABOR

- A. All materials used on this Contract shall be new and the best market quality unless specified or shown otherwise. All labor used on this Contract shall be competent and skilled for the Work. All work executed under this Contract shall be done in the best, most thorough, substantial and workmanlike manner. All material and labor shall be subject to the approval of the Architect as to its quality and fitness, and shall be immediately removed if it does not meet with approval. The Owner's Representative may refuse to issue a Certificate of Payment for unapproved work until all

defective materials or work have been removed and other material of proper quality substituted therefore.

GC 29. DELIVERY AND STORAGE OF MATERIALS

In addition to all other requirements of the Contract Documents, including without limitation the construction progress schedule, Contractor shall comply with the following with respect to materials:

- A. Contractor shall deliver all manufactured materials in the original packages, containers or bundles (with the seals intact) bearing the name or identification mark of all manufacturers.
- B. Contractor shall deliver fabrications in as large assemblies as practicable and where specified to be shop-primed or shop-finished, they shall be packaged or crated as required to preserve such priming or finish intact and free from abrasion.
- C. Contractor shall store all materials in such manner as necessary to properly protect them from damage. Materials or equipment damaged by handling, weather, dirt, or from any other cause will not be accepted. Contractor must replace or repair to as new condition any damaged materials or equipment.
- D. Contractor shall store materials so as to cause no obstructions. Materials shall be stored off sidewalks, roadways, and underground services. The Contractor shall be responsible for protecting all material and equipment furnished under the Contract.
- E. All materials stored off site for which Contractor seeks payment are subject to the requirements of GC 10, Terms of Payment. Contractor shall provide a detailed description of all such materials in a form and substance as required by County in its sole discretion as a condition precedent for payment for those materials.

GC 30. OLD MATERIAL

- A. Old material shall not be used.
- B. Construction materials or other items used or placed in the Work shall be considered old materials and not reused or reinstalled later. Materials purchased new and stored or handled such that they are no longer in factory-new condition prior to installation shall be considered old materials.

GC 31. TESTS

- A. Contractor shall comply with the requirements set forth in Division 01, General Requirements Sections and those set forth in the construction documents.
- B. If Contractor's performance of the work requires excess testing and inspection costs to the County, Contractor shall be responsible for, and pay to the Owner through deductive change order, costs of testing or inspection attributable to the following:
 - 1. Retesting due to failure of initial samples.
 - 2. Additional costs due to overtime work or extra shifts work because of improper scheduling of work or of delivery of materials by Contractor.
 - 3. Failure to properly notify laboratory or inspector.
 - 4. Changes in sources, lots or suppliers of materials after original tests.
 - 5. Changes in methods or materials of construction requested by Contractor that require testing, inspection, or other related services in excess of that required by original design.
 - 6. Concrete mix designs in excess of first successful design for each concrete type.
 - 7. Overtime or extra shift work requiring overtime work by Owner's Inspector.

GC 32. PATENT RIGHTS, COPYRIGHTS, TRADE NAMES AND ROYALTIES

A. The Contractor shall indemnify and save harmless the Owner and authorized persons acting for the Owner against all liability on account of any patent rights, copyrights or trade names which may affect the articles or materials or their application under the Contract.

B. The Contractor shall pay all royalties or other charges that may arise due to methods, types of construction, processes, materials or use of equipment and shall hold the Owner harmless from any claims or charges whatsoever which may arise; and shall furnish written assurance satisfactory to the Owner that such charges have been paid.

GC 33. COMPLIANCE WITH ALL LAWS

A. The Contractor shall conform to and abide by all applicable city, county, regional, state and federal building, labor, sanitary, health and safety laws, ordinances, rules and regulations as currently adopted or enforced, including Part 1 & 2 of Title 24, Calif. Code of Regulation and the International Building Code, International Fire Code, latest edition; Uniform Mechanical Code, latest edition; National Electrical Code, latest edition;; and the Uniform Plumbing Code, latest edition. The Project shall also comply with the Americans with Disabilities Act, and the latest editions of associated regulations; a copy of Title 24, CCR and the current California Building Code shall be made available at the job site at all times by the Contractor. Such laws and regulations shall be considered a part of the Contract Documents the same as if set forth herein full, and all work hereunder shall be executed in accordance therewith.

B. All work and materials shall be in full accordance with the latest rules and regulations of the State Fire Marshal, the Safety Orders of the Division of Industrial Safety, the National Electric Code, the Uniform Plumbing & Mechanical Codes published by the International Association of Plumbing and Mechanical Officials, and other applicable state laws or regulation including all of Title 24, Calif. Code of Regulation. Nothing in these plans or specifications is to be construed to permit work not conforming to these codes.

C. The Contractor shall be familiar with the various Federal, State and Local laws affecting public work, especially, but not limited to, those laws relating to hours of employment, minimum wage rates, payment of wages, sanitary and safety conditions for workmen, workmen's compensation insurance, type and kind of materials that can be used, non-discrimination in employment and affirmative-action programs. Contractor is advised that this is a Public Project which may be paid for, in whole or in part, by Federal, State and/or local funds. Contractor shall comply with applicable regulations and hold harmless the County for the Contractor's failure to comply. The identification or listing of certain of those laws, ordinances, rules and regulations in the Contract Documents does not excuse the Contractor from complying with other statutory requirements or provisions which are not set forth in these Contract Documents.

GC 34. PERMITS AND LICENSES

A. Unless otherwise provided in the Contract Documents, the Owner shall give all notices and procure and pay for permits and governmental fees, licenses and inspections necessary for the proper execution and completion of the Work which are customarily secured after execution of the Contract.

B. The Contractor shall obtain and pay fees for Encroachment Permits, Air Quality Permits, temporary utility services and connections from the Local Municipality, County of Humboldt, and CalTrans, Cal-OSHA, and Local Air Quality Management District as needed.

C. LICENSES: Professional, trade, business and other licenses required by state statute or local government are entirely the responsibility of the Contractor and subcontractors, and shall be prerequisite to submitting a bid proposal or performing work on the Project.

D. PERMITS:

1. Permits shall also include any cash deposits, returnable or otherwise, required by authorities having legal jurisdiction to make such demands;

2. Owner reserves the right to cancel and declare null and void the Contract should any legal permit be refused or not issued for any reason;
 3. Due to cancellation for said reasons, Owner will not consider any claims by Contractor for loss of anticipated profits; or for work performed or materials procured prior to obtaining all permits required herein.
- E. Contractor shall procure and deliver to the Construction Administrator in forms prescribed and complete with dates and authorized signatures, all certificates of inspection, testing or approvals required of or by State or Civil authorities having legal jurisdiction or any public authority bearing on the performance of the Work.
- E. The Contractor shall give all notices and comply with all laws, ordinances, rules, regulations and lawful orders of any public authority bearing on the performance of the Work.

GC 35. TEMPORARY FACILITIES

- A. The Contractor shall provide and maintain a temporary field base of operation on the sites. Said base of operation shall be for the exclusive use of the Contractor; and shall be wind and weatherproof, furnished with sufficient lighting to permit reading of blueprints. A complete set of Plans and Specifications shall be kept continuously at each site. When vacated, said structure shall be removed and the work in that area completed in accordance with the Contract requirements. Based on need, Contractor shall maintain and pay for all utilities and fuels; shall provide maintenance and other services necessary for proper use and operation; and comply with related provisions as specified.
- B. The Contractor shall maintain a viable communications system at each site acceptable to the Owner's Representative, and shall maintain the same until the final completion of the Contract and the acceptance of the Work. The Construction Administrator, Owner's Representative, Architect and Project Inspector shall have free and unrestricted use of this communications system for all purposes in conjunction with the Work.
- C. The Contractor shall provide water closets and urinals for use by its employees and subcontractors and their employees, and in no case shall the permanent plumbing fixtures of buildings on the site be used for this purpose without the written consent of the Owner's Representative.
- D. The Contractor and each subcontractor shall furnish, at their own expense, all tools, equipment, appliances, materials, scaffolding or other means necessary for the entire completion of the Work; and shall be responsible for the care and guarding of same.
- E. The Contractor and each subcontractor shall erect and maintain where necessary to the progress and completion of the Work, all exterior and interior scaffolding which shall be erected in accordance with the safety rules of the State of California; and use of which shall be unrestricted for all persons performing work on the Project.
- F. The Contractor shall pay the cost of all water, gas and electricity used by its employees or subcontractors during the process of the Work, or as required for temporary services or tests and inspections.
- G. Also refer to Division 01, General Requirements Sections.

GC 36. LIABILITY FOR ACCIDENTS

- A. The Contractor shall be liable for any and all loss, accident, neglect, injury, or damage to person, life or property which may be the result of or may be caused by its building operations or its execution of this Contract, and for which the Owner might be held liable; and shall protect and indemnify the Owner, the Owner's Representative, the Construction Administrator, the Project Inspector, the Architect, and/or any officer, agent or employee of the Owner and hold them harmless in every way from all claims and from all suits or actions at law for damage or injury to

persons, life or property that may arise or be occasioned in any way because of its building operations or its execution of this Contract.

B. Safety Precautions and Programs:

1. The Contractor shall be responsible for initiating, maintaining and supervising all safety precautions and programs in connection with the Work.

C. The Contractor shall assume the full responsibility for personnel safety on the Project and the means and methods of construction that pertain to personnel safety. Contractor is responsible that such means and methods of construction are adequate to provide safety to all personnel while accomplishing all requirements and standards of the Contract Documents. The Owner, Architect, Construction Administrator, Project Inspector and/or their representatives have no obligation, responsibility, or jurisdiction over safety or means and methods of construction that pertain to personnel safety on the Project.

GC 37. ACCIDENT PREVENTION

A. The Contractor shall erect and maintain, as required by existing conditions and progress of the Work, all reasonable safeguards for safety and protection, including posting danger signs and other warnings against hazards, and any other necessary construction required to secure safety of life or property; and shall maintain during all night hours sufficient lights to prevent accidents or damage to life or property.

B. No earth, building, temporary or other structure shall be loaded, used or stressed so as to endanger its safety.

C. In the event of an emergency affecting the safety of persons or property, the Contractor shall act, at its discretion, to prevent threatened damage, injury or loss. Claims by Contractor on account of alleged emergency actions shall be filed in writing with the Owner's Representative.

GC 38. EXISTING PREMISES AND IMPROVEMENTS

A. The Contractor shall care for, preserve and protect existing structures, utilities and other features, fixtures or improvements at the premises, including adjacent or co-terminus properties which are not required to be removed or altered by reason of work under this Contract; and shall, likewise, care for and protect work or improvements newly placed or recently installed at the premises. Any part or portion of said existing or newly placed improvements which are removed, damaged or disturbed because of this work, shall be replaced, cleaned or otherwise returned to the original condition entirely at the expense of the Contractor.

B. The removal and/or replacing of any existing structure, pipe, conduit, pavement or other existing improvement necessary for the proper completion of any work under the Contract shall be performed by the Contractor, and no claim for extra work shall be made on account of such removal and replacement.

C. In case it shall be necessary to remove any telephone, telegraph or electrical power transmission poles, water pipes, electrical conduits, or underground structures of any character, or any portion thereof, the Owner or its agents shall be notified by the Contractor and the Contractor shall make the necessary arrangements for such removal. The right is reserved to the Owner and to gas, water, telephone, telegraph and electrical power transmission companies to enter upon the Work for purpose of making repairs and changes that have become necessary by reason of work related to the Project.

D. The Contractor shall thoroughly investigate all existing poles, wires, pipes and conduits above and below ground and shall provide for the maintenance or replacing of same, in good condition and at

no expense to the Owner. Any necessary new or additional pipe or materials shall be furnished by the Contractor at its expense.

- E. At the completion of the Work, the Contractor shall furnish the Owner's Representative with a written certificate from the owner of each and all conduits, pipes or structures to the effect that such replacements and maintenance have been satisfactorily performed.
- F. The Contractor shall amply protect all work or improvements, set in the building or at the premises, against any possible damage; and shall furnish all necessary building paper, rough boarding or other means or materials necessary therefore.
- G. Also refer to Division 01, General Requirements Sections.

GC 39. USE OF PREMISES AND CLEAN-UP

- A. During the progress of the Work, materials shall be neatly stacked at such points so as not to interfere with site access and shall be properly cared for and protected against damage by weather or other causes. Project staging and parking area are defined in the plans.
- B. In the case where there are several contractors operating at one time, arrangements must be made to allow the joint use of storage space so as to prevent delays in the Work and unnecessary inconveniences.
- C. At the end of each working day, or as directed by the Owner's Representative, Construction Administrator, Project Inspector or Architect, the Contractor shall clean the building, premises, streets and adjacent properties of accumulated rubbish, debris, unnecessary appliances or any unused material which may constitute an obstruction to the progress or completion of the Work, whether the same was caused by its work or by the work of other crafts. Failure by the Contractor to maintain the site and building premises in a safe and clean condition will be considered a breach of contract and Contractor agrees to pay Owner for costs to have site cleaned and deduct said costs from any money due the Contractor under the contract.
- D. At the completion of the Work, and as one of the requisites thereof, the Contractor shall remove any and all tools, construction equipment, machinery, surplus materials, appliances, rubbish, packing, debris or other extraneous matter of any kind from the building, premises, sidewalks, streets or adjacent premises; Contractor shall go over all of its work and put the same in perfect order and condition and in strict accordance with the terms of the Contract; and shall repair or replace all damaged, broken or stained parts of its work, whether so injured by its workmen or others.
- E. No advertising signs of any kind shall be displayed on the building, premises, fences, offices or elsewhere upon the job, except the Project sign as called for in the specifications.
- F. At the completion of each phase of work of each kind of work or activity, the areas so used or involved shall be left in a "broom clean" condition daily unless otherwise more particularly required.

GC 40. DIRECTION OF THE WORK

- A. The Contractor shall do all of the Work and furnish all labor, materials, tools, and appliances, except as otherwise herein expressly stipulated, necessary or proper for performing the Work herein required in the manner and within the time herein specified. The mention of any specific duty or liability imposed upon the Contractor shall not be construed as a limitation or restriction of any general liability or duty imposed upon the Contractor by this contract, said reference to any specific duty or liability being made herein merely for the purpose of explanation. Until the completion and final acceptance by the Owner of all of the Work under and implied by the Contract Documents, the Work shall be under the responsible care and charge of the Contractor. The Contractor shall rebuild, repair, restore and make good all injuries, damages, re-erections and repairs occasioned or rendered necessary or caused of any nature whatsoever, excepting only acts of God not covered

- by the all-risk insurance policy called for in Article GC 4 and no other, to all or any portions of the Work except as otherwise expressly stipulated. Construction activities at the site shall be as required by the Contractor to complete the Project by the prescribed completion date. Contractor must comply with Noise Abatement Provisions required in other parts of the Plans and Specifications.
- B. The Contractor shall have control or charge over its subcontractors; shall be responsible to the Owner for the acts and omissions of its employees, subcontractors and their agents and employees, and other persons performing any of the Work under a contract with the Contractor, and for all orders or instructions from the Owner, Owner's Representative or the Architect. It shall be the Contractor's duty to see that all of the subcontractors commence their work properly at the proper time and carry it on with due diligence as not to cause delay or injury either to work or materials; and that all damage caused by them or their workmen be properly made good by them or by himself at no cost to the Owner.
- C. The Contractor shall keep on the work site at all times and until the acceptance certificate is issued, a competent Project Manager and Project Superintendent for the purpose of receiving and executing without delay any orders in keeping with the terms of the Contract issued by the Owner, Owner's Representative or Architect. This Superintendent shall have charge of Plans and Specifications kept on the job; shall be instructed to be familiarized closely with all the provisions of the Plans and Specifications and to follow them in a precise manner.
- D. If at any time the Superintendent or workman who shall be employed by the Contractor or any of its subcontractors shall be declared by the Owner's Representative to be incompetent or unfaithful in executing the Work, then the Contractor upon receiving written notice shall, forthwith, dismiss such person and shall not again employ him on any part of the Work.
- E. Contractor shall supervise and direct the Work using its best skill and attention, and shall be solely responsible for all construction means, methods, techniques, sequences and procedures and for coordinating all portions of the Work under the Contract; except that said responsibilities shall not be construed to permit use of any material, process, method or means if they are deemed unsuitable by Owner's Representative.
- F. Processing of Change Orders, Cost Proposals and like administrative matters, shall follow the procedures established and approved by the Owner at commencement of work under the Contract. Change orders and other forms shall be as approved by the Owner's Representative or otherwise required or directed by Owner. Refer to GC 12.
- G. Review of Contract Documents: The Contractor shall carefully study and compare the Contract Documents and shall at once report to the Architect and the Owner's Representative any conflict, error, inconsistency or omission Contractor may discover. Refer to GC 11 A.
- H. The Contractor shall not be relieved from its obligations to perform the Work in accordance with the Contract Documents by the activities or duties of the Owner's Representative or Construction Administrator in their administration of the Contract, or by inspections, tests or approvals required or performed under GC 31, by person other than the Contractor. The right of general supervision by the Owner shall not make the Contractor an agent or employee of the Owner, and the liability of the Contractor for all damages to persons or to public or private property arising from the Contractor's execution of the Work shall not be lessened because of such general supervision.
- I. Construction Progress Schedule:
In addition to the requirements herein regarding schedules, Contractor shall comply with all scheduling requirements of the Contract Documents, including, without limitation, Section 01 32 16, Construction Schedules.
1. The Contractor shall prepare and submit via the Construction Administrator to the Owner's Representative with copy to the Architect and the Project Inspector the Contractor's Initial Construction Schedule within ten (10) calendar days after date on the Notice to Proceed.

The Contractor's Initial Construction Schedule shall be comprised of either a Simple Gantt Chart, if the contract value is less than one million dollars (\$1,000,000), or a Critical Path Method network, if the contract value is one million dollars (\$1,000,000) or more. The Contractor's Initial Construction Schedule shall show the dates on which each part or division of the Work is expected to be started and completed, and shall show all submittals associated with each work activity, allowing a minimum of twenty one (21) calendar days (per GC 16 F) for the Architect's review of each submittal unless a longer period of time is specified elsewhere in these Contract Documents. The work activities making up the schedule shall be of sufficient detail to assure that adequate planning has been done for proper execution of the Work and such that, in the sole judgment of the Owner, it provides an appropriate basis for monitoring and evaluating the progress of the Work. The schedule shall show the interdependence of each activity and a single critical path. The Contractor shall also submit a separate progress schedule listing all submittals required under the contract and when it is anticipated that each submittal will be submitted.

2. The Contractor's Initial Construction Schedule shall show the sequence, duration in calendar days, and interdependence of activities required for the complete performance of all work. The Contractor's Initial Construction Schedule shall begin with the date of issuance of the Notice to Proceed and conclude with the date of final completion.
3. Float, slack time, or contingency within the schedule (i.e., the difference in time between the Project's early completion date and the required contract completion date), and total float within the overall schedule, is not for the exclusive use of either the Owner or the Contractor, but is jointly owned by both and is a resource available to and shared by both Owner and Contractor as needed to meet contract milestones and the contract completion date.
4. The Contractor shall not sequester shared float through such strategies as extending activity duration estimates to consume available float, using preferential logic, or using extensive crew/resource sequencing, etc. Since float time within the schedule is jointly owned, no time extensions will be granted nor delay damages paid until a delay occurs which extends the Work beyond the Contract completion date. Since float time within the construction schedule is jointly owned, it is acknowledged that Owner caused delays on the Project may be offset by Owner caused time savings (i.e., critical path submittals returned in less time than allowed by the contract, approval of substitution requests which result in a savings of time to the Contractor, etc.). In such an event, the Contractor shall not be entitled to receive a time extension or delay damages until all Owner caused time savings are exceeded and the contract completion date is also exceeded.
5. Comments made by the Owner on the Contractor's Initial Construction Schedule during review will not relieve the Contractor from compliance with the requirements of the contract documents. The review is only for general conformance with the scheduling requirements of the contract documents. Upon the Owner's request, the Contractor shall participate in the review of the Contractor's Initial Construction Schedule submissions (including the original submittal, all update submittals, and any re-submittals). The Owner may request the participation of subcontractor in these reviews, as determined necessary by the Owner. All revisions shall be resubmitted within fifteen (15) calendar days after the Owner's review.
6. The submittal of a fully revised and acceptable Contractor's Initial Construction Schedule shall be a condition precedent to the processing of the first monthly payment application.
7. On any project with a construction value equal to or greater than one million dollars (\$1,000,000), the Contractor must submit a Critical Path Method (CPM) network. The network shall provide a workable plan for monitoring the progress of all the elements of the Work, establish and clearly display the critical elements of the Work, forecast completion of the construction, and match the contract duration in time. Exclusive of those activities for submittal review and material fabrication and delivery, activity duration shall not be less than one (1) nor more than thirty (30) calendar days, unless otherwise approved by the Owner. In addition to the detailed network diagram, the Contractor shall submit the following reports with the original submittal and all updates and revisions:
 - a. Predecessor/Successor Report or a list showing the predecessor activities and successor activities for each activity in the schedule.
 - b. Activity Report sorted by early start or a list showing each activity in the schedule, arranged by early start dates.

8. Regardless of which schedule method the Contractor elects to use in formulating the Contractor's construction schedule, and unless the Owner's Representative in writing each month, specifically waives this requirement, an updated construction schedule shall be submitted to the Owner's Representative five (5) days prior to the submittal of the Contractor's monthly payment request. The submittal of the updated construction schedule which satisfies the requirements of the Contract Documents accurately reflects the status of the Work, and incorporates all changes into the schedule, shall be a condition precedent to the processing of the monthly payment application. Updated schedules shall also be submitted at such other times as the Owner may direct. Upon approval of a change order or issuance of a direction to proceed with a change, the approved change shall be reflected in the next schedule update submittal by the Contractor, or other update submittal approved by the Owner.
 9. If completion of any part of the Work, the delivery of equipment or materials, or submittal of the Contractor submittals is behind the updated construction schedule and will impact the end date of the Work past the contract completion date, the Contractor shall submit in writing, a plan acceptable to the Owner for completing the Work on or before the current contract completion date.
 10. No time extensions shall be granted nor delay damages paid unless the delay can be clearly demonstrated by the Contractor on the basis of the updated construction schedule current as of the month the change is issued or the delay occurred and which delay cannot be mitigated, offset, or eliminated through such actions as revising the intended sequence of work or other means. Contractor shall submit all disputes or claims under the provisions of GC 51, Claims Procedure, otherwise it shall be waived.
 11. As a condition precedent to the release of retained funds, the Contractor shall, after completion of the Work has been achieved, submit a final Contractor's construction schedule which accurately reflects the manner in which the Project was constructed and includes actual start and completion dates for all work activities on the construction schedule.
- J. The Contractor shall forward all communications to the Owner, Project Inspector, Owner's Representative and Architect through the Construction Administrator.
- K. The Contractor shall maintain a digital set of Plans and Specifications in pdf format and make them accessible to the Construction Administrator, Project Inspector, Architect and Owner's Representative at all times. The Contractor shall identify and dimension upon these Plans the exact locations of all pipes, conduits, ductwork and all changes in construction and details, and identify in these Specifications all changes in materials and equipment. Refer to Sections 01 77 00, Closeout Procedures and 01 78 39, Project As-Built Documents for requirements. The as-built Plans and Specifications shall be current (up-to-date) to qualify for payment and subject to verification by the Construction Administrator, Project Inspector, Architect or Owner's Representative prior to payment application approval. Upon completion of the Work, the Contractor shall provide these as-built Plans and Specifications for review by the Construction Administrator, Architect and Owner's Representative prior to the final payment. The as-built Plans and Specifications shall be coordinated, neatly drafted and submitted as a marked-up .pdf file. The requirements set forth herein are in addition to, and complementary of, the requirements set for in Section 01 77 00, Closeout Procedures and Section 01 78 39, Project As-Built Documents.

GC 41. CUTTING, FITTING AND PATCHING

- A. The Contractor shall do all cutting, fitting and patching of work that may be required to make its several parts come together properly, and prepare it to join or be joined by the work of other contractors; and Contractor shall make good after them.
- B. The Contractor shall not endanger any work by cutting, digging or otherwise; and shall not cut or alter the work of any other contractor without the written consent of the Architect; and shall not cut a beam, timber or support of any kind without the consent of the Architect. Under no circumstances

shall any principal brace, timber, truss, support or other structural member be cut or structurally weakened in any way.

- C. Where the construction is required to join with or match existing work, it shall be finished exactly similar to that work so as to form complete, unified and finished work.
- D. Contractor shall be responsible for and particularly supervise each and every operation and all work which in any way may affect the structural integrity of the various works, including below, on, or above grade structures, and whether for temporary or permanent work.
- E. Any cost for repairs or restoration caused by cutting, digging or otherwise due to ill-timed or defective work shall be borne by the Contractor.
- F. Also refer to Division 01, General Requirements Sections.

GC 42. RIGHT TO OCCUPY OR USE

- A. The Owner reserves the right to occupy or use any part or parts, or the entirety of the building and/or grounds when the Owner deems the same may be safe for use or occupancy.
- B. The exercising of this right shall in no way constitute an acceptance of such parts, or any part of the Work, nor shall it in any way affect the dates and times when payments shall become due from the Owner to the Contractor, nor shall it in any way prejudice the Owner's right under the Contract or any bonds guaranteeing the same. The Contract shall be deemed completed only when all the work contracted for shall be duly and properly performed and accepted by the Board of Supervisors.
- C. When any part or portion of the Project is to be used or occupied by Owner in advance of final completion and acceptance, and when duly notified by Owner's Representative, the Contractor shall arrange for completion of said portions of the Work the same as required under the Documents for the whole Work, including cleaning and other readying by the date stipulated with such notice.
- D. Contractor shall not be held responsible for any damage to the occupied part of the Project resulting from Owner's occupancy.
- E. Occupancy by Owner shall not be deemed to constitute a waiver of existing claims on behalf of Owner or Contractor against each other.
- F. Use and occupancy by Owner prior to Project acceptance shall not relieve Contractor's responsibility to maintain all insurance and bonds required of Contractor under the Contract until the entire Project is completed and accepted by Owner.
- G. If after written notification by the Owner of the intent to occupy, the Contractor feels that such occupancy will delay progress of the Work or will cause additional expense to the Contractor, Contractor may file a request for an equitable adjustment in Contract Price or Time of Completion, or both, with the Owner's Representative. If the Owner's Representative agrees he will either prepare a written change order for the Owner to sign or advise the Owner to delay occupancy.

GC 43. CHANGE OF CONTRACT TIME & LIQUIDATED DAMAGES

- A. Change by Change Order. The Contract Time may only be changed by change order. A request for an extension or shortening of the Contract Time shall be based on written notice delivered by the party making the request to County promptly after the occurrence of the event giving rise to the request and stating the general nature of the request. Notice of the extent of the request with supporting data shall be delivered to County and shall be accompanied by the written statement that the adjustment requested is the entire adjustment to which the requesting party has reason to believe it is entitled as a result of the occurrence of said event. No request for an adjustment in the Contract Time will be valid if not submitted in accordance with the requirements of this paragraph.

- B. Contract Time may be extended. The Contract Time will be extended in an amount equal to time lost due to delays beyond the control of Contractor if the request is made therefor as provided in this article. Such delays shall include, but not be limited to, acts of neglect by County or others performing additional work, or to fires, floods, labor disputes, epidemics, pandemics, abnormal weather conditions or acts of God.
- C. Delay and price change. All time limits stated in the contract documents are of the essence. There shall be no adjustment of Contract Price due to delays for fires, floods, labor disputes, epidemics, pandemics, abnormal weather conditions or acts of God. This provision shall not exclude recovery for damages (including but not limited to fees and charges of engineers, architects, attorneys and other professionals and court costs) for delay by either party.
- D. Delays in completion of work :
1. Notice of delays. Whenever the Contractor foresees any delay in the prosecution of the Work, and in any event immediately upon the occurrence of any delay which the Contractor regards as unavoidable, Contractor shall notify County in writing of the probability of the occurrence of such delay and its cause in order that County may take immediate steps to prevent, if possible, the occurrence or continuance of the delay or, if this cannot be done, may determine whether the delay is to be considered avoidable or unavoidable, how long it continues, and to what extent the prosecution and completion of the Work are to be delayed thereby. It will be assumed that any and all delays which have occurred in the prosecution and completion of the Work have been avoidable delays, except such delays as shall have been called to the attention of County at the time of their occurrence and found by County to have been unavoidable. The Contractor shall make no requests for extensions of time as to delay not called to the attention of County at the time of its occurrence.
 2. Avoidable delays. Avoidable delays in the prosecution or completion of the Work shall include all delays which in the opinion of County would have been avoided by the exercise of care, prudence, foresight and diligence on the part of the Contractor or Contractor's subcontractors.
 3. Unavoidable delays. Unavoidable delays in the prosecution or completion of the Work shall include all delays which, in the opinion of County, result from causes beyond the control of the Contractor and which could not have been avoided by the exercise of care, prudence, foresight and diligence on the part of the Contractor or the subcontractors and/or any suppliers. Delay in completion due to contract modifications ordered by County and unforeseeable delays in the completion of work or interference by other contractors employed by County will be considered unavoidable delays insofar as they interfere with the Contractor's completion of the Work.
- E. Extension of time:
1. Avoidable delays. In case the Work is not completed in the time specified, including such extensions of time as may have been granted for unavoidable delays, the Contractor will be assessed damages for delay in accordance with liquidated damages provision. The Owner, however, shall have the right to grant an extension of time for avoidable delay if it is deemed in County's best interest to do so. During such extension of time, the Contractor will be charged for engineering and inspection services and other costs but will not be assessed damages for the delay.
 2. Unavoidable delays. For delays which County considers to be unavoidable, the Contractor shall, pursuant to Contractor's application, be allowed an extension of time beyond the time herein set forth, proportional to such delay or delays, in which to complete the contract. During such extension of time, neither extra compensation for engineering and inspection provided nor damages for delay will be charged to the Contractor.
 3. Liquidated damages. County and Contractor recognize that time is of the essence and that County will suffer financial loss if the Work is not completed within the time specified above, plus any extensions thereof allowed in accordance with this contract. They also recognize the delays, expense and difficulties involved in proving the actual loss suffered by County if the Work is not completed on time. Accordingly, instead of requiring any such proof, and due to impracticality and difficulty of ascertaining exact damages caused by

delay, County and Contractor agree that as liquidated damages for delay (but not as a penalty) Contractor shall pay County that amount set forth in the Contract, or if no such amount is specified, then one-half of one percent of the total Contract Price for each day that expires after the time specified above for completion. In case of joint responsibility for delay in the final completion of the Work, where two or more separate contracts are in force at the same time and cover work at the same site, liquidated damages assessed against any one Contractor will be based upon the individual responsibility of that Contractor for the delay as determined by, and in the judgment of, County. County shall have the right to deduct the liquidated damages from any money in its hands, otherwise due, or to become due, to Contractor, or to sue for and recover compensation for damages for nonperformance of this contract within the time stipulated. County has determined and the Contractor acknowledges that the liquidated damages as established herein are governed by the provisions of Government Code § 53069.85 and are predicated upon the reasonable damages accruing to County stemming from any delay in the completion of this Project.

GC 44. HOURS OF WORK

- A. The time of service of any labor, workman or mechanic employed upon any of the work herein specified, shall be limited and restricted to that allowed by law, and no laborer, workman or mechanic employed upon said work herein specified shall be required or permitted to labor more than that allowed by law, except in cases of extraordinary emergency caused by fire, military or naval defenses or works in time of war.
- B. Within thirty (30) calendar days after any workman is permitted to work over that allowed by law in any one calendar day due to such an extraordinary emergency, the Contractor shall file with the Owner a verified report setting forth the nature of the said emergency, which shall contain the name of said workman and the hours worked by them on said particular day; and failure to file said report within the said thirty day period shall be prima facie evidence that no extraordinary emergency existed.
- C. The Contractor and each subcontractor shall keep an accurate record showing the name of and actual hours worked by each worker employed by said Contractor and subcontractor in connection with the work contemplated by this agreement. The record shall be kept open at all reasonable hours to inspection by the Owner or its officers or agents and by the Division of Labor Law Enforcement of the Department of Industrial Relations.
- D. The Contractor shall forfeit as a penalty to the Owner twenty-five dollars (\$25) for each laborer, workman or mechanic employed in the execution of this Contract by it or by any subcontractor under it, upon any public work herein specified for (a.) each calendar day during which any laborer, workman or mechanic is required or permitted to labor more than that allowed by law; or (b.) each calendar week during which any laborer, workman or mechanic is required or permitted to labor more than that allowed by law of the Labor Code of the State of California. Said sums and amounts which shall have been so forfeited pursuant to the herein paragraph and said provisions of said Labor Code shall be withheld and retained from payments due to the Contractor under this Contract, pursuant to this Contract, and the terms of said Labor Code. ;

GC 45. PREVAILING WAGE RATES & PAYROLL RECORDS

Contractor shall comply with all requirements of Federal and California law with respect to labor relations, including without limitation, as to the payment of prevailing wages, working hours, payroll records and apprentices. To the extent that there is anything in this Agreement in conflict with or inconsistent with Federal or California law, such law shall govern and control.

A. Prevailing Wage Rates

- 1. Pursuant to section 1770 and following of the Labor Code of the State of California, the Director of Industrial Relations has ascertained the general prevailing rate of per diem wages and the rates for overtime and holiday work in the locality in which the work is to be performed for each craft, classification or type of worker needed to execute the Contract

which will be awarded to the successful bidder, copies of which are on file at Humboldt County Public Works, 1106 Second Street, Eureka, CA 95501, Phone (707) 445-7493 and are available to interested parties on request and by reference are incorporated herein and made a part hereof. Contractor will maintain a copy of prevailing rates and wages on the job site during the contract period.

2. It shall be mandatory upon the Contractor and upon any subcontractor under it, to pay not less than the specified rates to all laborers, workers, and mechanics employed in the execution of the Contract. It is further expressly stipulated that the Contractor shall, as a penalty to the Owner, forfeit not more than \$200 for each calendar day, or portion thereof, for paying less than the stipulated prevailing rates for any work done under this Contract by Contractor or by any subcontractor under it; and Contractor agrees to comply with all provisions of Section 1775 of the Labor Code.
 3. In case it becomes necessary for the Contractor or any subcontractor to employ on the Project under this Contract any person in a trade or occupation (except executives, supervisory, administrative, clerical, or other non-manual workers as such) for which no minimum wage rate is herein specified, the Contractor shall immediately notify the Owner, who will promptly thereafter determine the prevailing rate for such additional trade or occupation and shall furnish the Contractor with the minimum rate based thereon. The minimum rate thus furnished shall be applicable as a minimum for such trade or occupation from the time of the initial employment of the person affected and during the continuance of such employment. Each contractor shall file a certified copy of the payroll records with the entity that requested the records within ten (10) days after receipt of a written request.
 4. Any copy of records made available for inspection as copies and furnished upon request to the public or any public agency by the Owner, shall be marked or obliterated in such a manner as to prevent disclosure of an individual's name, address, and social security number. The name and address of the contractor awarded the contract for performing the contract shall not be marked or obliterated.
 5. The Contractor shall inform the Owner of the location of the payroll records, including the street address, city and county, and shall, within five working days, provide a notice of any change of location and address.
 6. The Contractor shall be responsible for compliance with this section.
- B. Payroll Records. The Contractor agrees to comply with all requirements of Section 1776 of the Labor Code, including, without limitation, the following:
1. The Contractor and each subcontractor shall keep an accurate payroll record, showing the name, address, social security number, work classification, straight time and overtime hours worked each day and week, and the actual per diem wages paid to each journeyman, apprentice, worker, or other employee employed by it in connection with the public work. Each payroll record shall be verified by written declaration, under penalty of perjury, stating both the following:
 - a. The information contained in the payroll record is true and correct.
 - b. The employer has complied with the requirements of sections 1771, 1811 and 1815 of Labor Code for any work performed by its employees on the Project.
 2. The above-referenced payroll records shall be certified and shall be available for inspection at all reasonable hours at the principal office of the Contractor on the following basis:
 - a. A certified copy of an employee's payroll record shall be made available for inspection or furnished to the employee or his/her authorized representative on request;
 - b. A certified copy of all payroll records shall be made available for inspection or furnished upon request to the Owner or the Division of Labor Standards Enforcement.
 - c. A certified copy of all payroll records shall be made available upon request by the public for inspection or copies thereof made; provided, however, that a request by the public shall be made through either the Owner or the Division of Labor Standards Enforcement. If the requested payroll records have not been provided, pursuant to paragraph b. above, the requesting party shall, prior to being provided the records, reimburse the cost of the Contractor, subcontractors, and the entity through which the request was made. The public shall not be given access to the records at the principal office of the Contractor.

C. Pursuant to Section 1771.1(a) of the California Labor Code, a contractor or subcontractor shall not be qualified to bid on, be listed in a bid proposal, subject to the requirements of Section 4104 of the Public Contract Code, or engage in the performance of any contract for public work, as defined in Sections 1770 et seq. of the Labor Code, unless currently registered and qualified to perform public work pursuant to Section 1725.5 of the Labor Code. It is not a violation of Section 1771.1(a) for an unregistered contractor to submit a bid that is authorized by Section 7029.1 of the Business and Professions Code or by Section 10164 or 20103.5 of the Public Contract Code, provided the contractor is registered to perform public work pursuant to Section 1725.5 at the time the contract is awarded.

GC 46. TAXES

A. Any federal, state or city tax, including sales, excise, use and other taxes payable on articles furnished by the Contractor under the Contract shall be included in the Contract Price and paid for by the Contractor.

GC 47. SUBCONTRACTORS

A. In accordance with the provisions of Section 4100 et seq. of the Public Contract Code of the State of California, each bidder for the Work herein specified shall set forth in its Bid Proposal the name and location of the place of business of each subcontractor who will perform work or labor or render service to the Contractor in or about the construction of the Work or improvements in an amount in excess of one-half (1/2) of one percent (1%) of the Contractor's total Base Bid; and the portion of the Work which will be done by each subcontractor if the Contract or said work is awarded to said Bidder.

B. If the Contractor fails to specify a subcontractor or specifies more than one subcontractor for the same portion of the Work to be performed on the Contract in excess of one-half of one percent of the Contractor's total Bid, Contractor agrees to perform such portion himself and, if Contractor's Bid is accepted, Contractor shall not be permitted to subcontract that portion of the Work.

C. Should the Contractor violate any provision of the subletting and subcontracting Fair Practices Act, the Contractor will be deemed in violation of the contract and the Owner may at its option, (1) cancel the Contract. (2) assess upon the Contractor a penalty in an amount of not more than ten percent (10%) of the amount of the subcontract involved.

D. Prior to the award of the Contract, the Owner's Representative shall notify the successful bidder in writing if the Owner, after due investigation, has reasonable objection to any person or organization on the required list of subcontractors.

E. The Contractor shall not contract with any subcontractor or any person or organization for any portion of the Work who has not been accepted by the Owner. The Contractor will not be required to contract with any subcontractor or person or organization against whom Contractor has a reasonable objection.

F. If after the award of the contract, the Owner refuses to accept any person or organization on the required list of subcontractors, the Contractor shall submit an acceptable substitute and the Contract Price shall be increased or decreased by the difference in cost occasioned by such substitution, and an appropriate Change Order shall be issued; however, no increase in the Contract Price shall be allowed for any such substitution unless the Contractor has acted promptly and responsively in submitting a name with respect thereto prior to the award.

G. After the award, the Contractor shall resubmit the list of subcontractors, corrected or modified as may be necessary as directed by the Owner.

H. Subcontracting

1. Nothing contained in the Contract Documents shall be construed as creating any contractual relationship between Owner and any subcontractor. The Divisions or Sections

- of the Specifications, and the divisioning of the Drawings are not intended to control the Contractor in dividing the Work among subcontractors or to limit the Work performed by any trade.
2. The Owner, Owner's Representative or Architect will not undertake to settle any differences between the Contractor and its subcontractors or between subcontractors.
 3. The Contractor shall cause appropriate provisions to be inserted in all subcontracts relative to the Work: (a) to bind subcontractors to the Contractor to the terms of the Contract and these General Conditions and other Contract Documents insofar as applicable to the work of subcontractors; (b) to require subcontractors to assume towards Contractor all the obligations and responsibilities which Contractor, by these Contract Documents, assumes toward Owner; (c) that requires subcontractor to agree to an assignment of the subcontract to the Owner and/or to any third party as designated by the Owner in its sole discretion, including without limitation, a replacement contractor; and (d) to give the Contractor the same power as regards terminating any subcontract that the Owner may exercise over the Contractor under any provision of the Contract Documents. The Contractor shall make available to each proposed subcontractor prior to the execution of the subcontract, copies of the Contract Documents to which the subcontractor will be bound by this paragraph and identify to the subcontractor any terms and conditions of the proposed Subcontract which may be at variance with the Contract Documents. Each subcontractor shall similarly make copies of such documents available to its sub-subcontractors.
 4. Each subcontractor shall be required to:
 - a. Enter into a written contract with Contractor acknowledging that no employee/employer relationship exists between Contractor and subcontractor and that no Workers' Compensation, unemployment benefits, or other personnel benefits are required by or available to subcontractor through Contractor or County.
 - b. Hold harmless and to indemnify, defend and save harmless Contractor and County and its Board Members, officers and officials, Owner's Representative, Construction Administrator, Project Inspector, and the Architect and their agents, employees and volunteers, from any and all claims and losses accruing or resulting to any and all contractors, subcontractors, material suppliers, laborers, and any other person, firm or corporation who may be injured or damaged by subcontractor in the performance of this Agreement.
 5. The Contractor shall:
 1. Schedule and coordinate the work of all subcontractors;
 2. Instruct all subcontractors to consult with other subcontractors to ascertain the locations of their various materials including stored materials and to familiarize themselves with their own material locations, making such changes as required to obtain the best results;
 3. Instruct all subcontractors to schedule their work and cooperate with the other subcontractors to avoid delays, interferences, and unnecessary work, to conform to the schedule of operations as indicated in the progress schedule, and make installations when and where directed;
 4. Require subcontractors to make all necessary changes, including removing and reinstalling of materials, at their sole expense if they fail to check with other subcontractors, and their installed work is later found to interfere with work of other subcontractors; and
 5. Follow up to ensure that all subcontractors install their work when and where directed, and in accordance with the Contract Documents.
- I. Payments to Subcontractors:
1. Contractor shall pay each subcontractor or supplier upon receipt of payment from Owner, an amount equal to the percentage of completion allowed to Contractor on account of such work performed or material supplied. Contractor shall also require each subcontractor to make similar payments to its subcontractors or suppliers.
 2. Contractor shall pay each subcontractor a just share of any insurance monies received by Contractor when and as applicable, and Contractor shall require each subcontractor to make similar payments to their subcontractors or suppliers.

3. The Owner's Representative may, on request and at its discretion, furnish to any subcontractor, if practicable, information regarding percentages of completion certified to the Owner on account of work done under the Contract.
4. Neither Owner, Owner's Representative or Architect shall have any obligation to see to the payment of any monies to any subcontractor except as may otherwise be required by law.

GC 48. RECORDS, ACCOUNTS AND SEGREGATED PRICES

- A. The Contractor must maintain all books, records, documents, and other evidence directly pertinent to the performance of the Work in accordance with generally accepted accounting principles and practices consistently applied. The Contractor must also maintain all financial information and data used by the Contractor in the preparation or support of any cost application, or other request for equitable adjustment. Owner and its representatives will have access upon 24 hours advanced written notice, at all times during normal business hours, to all Contractor's books, summary reports, records, accounts, estimates, documents, detailed financial information, certified payroll records, and all other relevant information and documentation for the purposes of inspection, audit, and copying. The Contractor will, at no cost to Owner, provide proper facilities for such access, inspection and copying purposes.

Contractor shall prepare a detailed daily report in a format and containing substance subject to Owner's approval, which shall record, at a minimum, the daily work performed, the names of the trades (subcontractors) performing work and the quantity of workers for each trade, the work performed, materials delivered, equipment stored on site, weather, inspections and tests performed (and their results) and factual information sufficient to detail the daily events. All such reports shall be signed by Contractor's representative and delivered, on a weekly basis, to Owner. The Contractor shall include in the daily report information that identifies any impacts to Contractor's (including all subcontractors') activities and their productivity that Contractor contends or observes is due to conduct for which the Owner is believed to be responsible. The absence of any such notice will be understood by Owner to be an acknowledgement that Owner did not cause or contribute to any delays or impacts to the Project. Preparing and providing such daily reports is not a substitution for, or in place of the requirements of, or Contractor's obligations under, the Contract Documents.

- B. Contractor agrees to include and make the requirements of this section applicable to all subcontracts, of any tier, or purchase orders in excess of \$10,000, at any tier.
- C. If required for convenience of Owner's accounting, Contractor shall furnish segregated prices for various other portions of the Work. These segregated prices shall be in addition to or separate from the required Schedule of Values.
- D. Records must be maintained and made available during the performance of work and for five (5) years after final payment, and until final settlement of all disputes, claims, or litigation, whichever occurs later. In addition, those records which relate to any portion of this Agreement, to any change order, to any dispute, to any litigation, to the settlement of any claim arising out of such performance, or to the cost or items to which an audit exception has been taken, must be maintained and made available until final payment or final resolution of such dispute, litigation, claim, or exception, whichever occurs later.
- E. The right of access provisions of this section applies to all financial records pertaining to this Agreement:
- (1) to the extent the records pertain directly to Contract performance under the Agreement;
 - (2) to the extent required for verification of the costs incurred where such costs are the basis for billings pursuant to this Agreement including Change Orders;
 - (3) to the extent there is any indication of violation of the California False Claims statute or that fraud, gross abuse, or corrupt practices may be involved;
 - (4) if the Agreement is terminated for default or convenience.

GC 49. LIABILITY FOR TREES

- A. In case of damage to or loss of trees due to carelessness or lack of sufficient protective measures specified, Contractor shall forfeit an amount as agreed to following the assessment and determination of replacement cost by an independent professional arborist.

GC 50. LIABILITY FOR SURVEY MARKS

- A. In case of damage to, disturbance or removal of survey marks, field markers, monuments, or other survey or layout devices due to carelessness or lack of sufficient protective means, the party responsible for such damage, disturbance or removal shall be liable for the expense to have them replaced and reset pursuant to Section 8771 of the California Business and Professions Code.

GC 51. CLAIMS PROCEDURES

A. Notice of Potential Claim (NOPC)

1. The Contractor is not entitled to additional compensation for any cause, including a disagreement, protest, or change, an act or failure to act by the County, or the happening of an event, thing or occurrence, unless the Contractor has given the County advance written notice of potential claim (NOPC). The NOPC must clearly describe the nature, circumstances, and basis of the potential claim, and must explain the reasons that the Contractor believes additional compensation and/or time will or may be due, the nature of the costs and/or time involved, the amount of the potential claim, a request for equitable adjustment, and written and verifiable documentation and support. The nature, circumstances, basis, and reasons must remain consistent.
2. Except as otherwise required in the Contract Documents, the Contractor must promptly provide an NOPC to the County upon discovery of concealed or unknown conditions or a disagreement, protest, situation, event, or occurrence that may result in a claim. This notice must be submitted no more than 7 Calendar Days after the discovery or occurrence of an event that may be the basis for a claim for additional compensation or time; failure to do so waives the claim.
3. If costs or time cannot be reasonably determined at the time the NOPC is provided, the NOPC must be amended to include quantified cost and time impacts within 30 Calendar Days after work has ceased on the event that prompted the NOPC; failure to do so waives the claim. For NOPC events that extend more than 30 Calendar Days the Contractor must provide a monthly accounting of ongoing costs and time impacts by the 5th day of the succeeding month; failure to do so waives the claim.

B. Duty to Mitigate Damages

1. The Contractor is required to take all reasonable and practical efforts to mitigate the damaging effects of a potential current or future claim it perceives as a result of an act or failure to act on the part of the County, or as a result of an event, thing or occurrence. Written notice by the Contractor of a potential claim does not excuse the Contractor from pursuing the mitigation of a claim in good faith and with due diligence. Where possible, or if directed by the County, the Contractor must be prepared to discuss various methods of mitigation with the County prior to actual mitigation.
2. The obligation to minimize foreseeable damages requires that the Contractor use reasonable care and diligence to prevent an unwarranted incurrence of damages from a delay caused by the other party or an unforeseen event. In evaluating a delay, if, in the opinion of the County, the delay could have been avoided by due care of the Contractor, the Contractor is responsible for the additional costs attributed to the failure to mitigate.

- C. Contractor's surety or sureties shall be bound by any award or judgment rendered in any proceeding arising from the Project or undertaken in accordance with the Contract Documents. Further, Contractor's surety or sureties shall be bound by and subject to the dispute resolution provisions set forth herein, and Contractor's surety or sureties shall, at the request of County (or Contractor), participate in any dispute resolution proceedings, including mediation or litigation, that occur pursuant to the Contract Documents.
- D. The County and Contractor intend that differences between the County and Contractor, arising under the Agreement, be brought to the attention of the County at the earliest possible time in order that such matters may be settled, if possible, or other appropriate action promptly taken. The County and Contractor agree to initially strive to resolve all disputes amicably and in an informal manner. If the dispute resolution involves a change in the Contract work, increase or decrease in the compensation due the contractor, or adjustment in the time of completion of the Work, then the informal dispute resolution shall be confirmed by a Change Order pursuant to the Contract Documents. Informal discussions or negotiations with the County or its representatives concerning informal resolution of a dispute shall not toll or suspend the claim filing and other deadlines provided below, unless so provided by the County in writing. Contractor, and Contractor's surety or sureties, shall be bound by and subject to the dispute resolution provisions as set forth herein, and Contractor's surety or sureties shall, at the request of the County (or Contractor), participate in any dispute resolution proceedings, including mediation, arbitration or litigation that may occur pursuant to the Contract Documents.

Nothing set forth herein constitutes a waiver of the government claim filing requirements pursuant to Title 1, Division 3.6 of the California Government Code or otherwise set forth in local, state and federal law.

- E. Contractor shall not be entitled to any additional time to complete work or to the payment of any additional compensation for claimed extra work (or otherwise on account of any claim, cause, act, failure to act, or happening of any event or occurrence) unless the County has issued a Change Order pursuant to the Contract Documents, or a Claim has been timely filed and approved pursuant to the Contract Documents. If the Contractor fails to timely file a written Claim in accordance with the Contract Documents, then the Contractor shall be deemed to have waived any right or remedy to thereafter pursue the claim against the County in any administrative, arbitration or litigation proceeding.
- F. For purposes of this section:
1. "Claim" means a separate demand by the Contractor sent by registered mail or certified mail with return receipt requested, for one or more of the following:
 - a. A time extension, including, without limitation, for relief from damages or penalties for delay assessed by the County under the Contract for the Project.
 - b. Payment by the County of money or damages arising from work done by, or on behalf of, the Contractor pursuant to the Contract for the Project and payment for which is not otherwise expressly provided or to which the claimant is not otherwise entitled.
 - c. Payment of an amount that is disputed by the County.
 2. "Contractor" means any type of contractor within the meaning of Chapter 9 (commencing with Section 7000) of Division 3 of the California Business and Professions Code who has entered into a direct contract with the County for the Project.
 3. "Subcontractor" means any type of contractor within the meaning of Chapter 9 (commencing with Section 7000) of Division 3 of the California Business and Professions Code who either is in direct contract with a Contractor or is a lower tier subcontractor.

G. Requirements for Filing of Contract Claim; Contents; Filing Deadline

1. Contents. The Contractor may file a "Contract Claim" with the County. A Contract Claim must (a) be in writing; (b) be labeled or clearly indicated as a claim under the Agreement; (c) set forth in detail the reasons why the Contractor believes additional compensation or a time extension is or may be due, the nature of the costs involved, and, insofar as possible,

the amount of the Claim; (d) include (or reference earlier provided) documents that support and substantiate the Claim; and (e) include the following certification, properly completed and executed by Contractor or any officer of Contractor:

I, _____, BEING THE _____ (must be an owner or officer) OF _____ (CONTRACTOR), DECLARE UNDER PENALTY OF PERJURY UNDER THE LAWS OF THE STATE OF CALIFORNIA, AND I DO PERSONALLY CERTIFY AND ATTEST THAT: I HAVE THOROUGHLY REVIEWED THE ATTACHED CLAIM FOR ADDITIONAL COMPENSATION AND/OR EXTENSION OF TIME, AND KNOW ITS CONTENTS, AND SAID CLAIM IS TRUTHFUL AND ACCURATE; THAT THE AMOUNT AND/OR CONTRACT TIME EXTENSION REQUESTED ACCURATELY REFLECTS THE CONTRACT ADJUSTMENT FOR WHICH THE OWNER IS LIABLE; AND FURTHER, THAT I AM FAMILIAR WITH CALIFORNIA PENAL CODE SECTION 72 AND CALIFORNIA GOVERNMENT CODE SECTION 12650, ET SEQ., PERTAINING TO FALSE CLAIMS, AND FURTHER KNOW AND UNDERSTAND THAT SUBMISSION OR CERTIFICATION OF A FALSE CLAIM MAY LEAD TO FINES, IMPRISONMENT AND/OR OTHER SEVERE LEGAL CONSEQUENCES.

2. Filing Deadline. A Contract Claim must be submitted to the County within the following Claim filing deadlines: (a) if a deadline is set forth in the Contract Documents for filing of the particular Claim, then the Claim must be filed by the specified time; (b) if the Claim relates to extra, additional or unforeseen work for which the Contractor intends to demand additional compensation, a time extension, or both, notice shall be given to the County prior to the time that the Contractor commences performance of the work giving rise to the potential claim for additional compensation or time extension, and Contractor shall not proceed with that work until so directed by the County; and (c) for all other Claims not included within (a) or (b), the claim must be filed on or before 15 days after the date of the occurrence, event or circumstance giving rise to the Claim. In no event shall a Contract Claim be filed later than the date of final payment.

H. Claims Subject to Public Contract Code Section 9204; Procedure

1. Application. This subsection H applies solely to the handling and resolution of a Contract Claim(s) sent to the County by registered mail or certified mail with return receipt requested in accordance with Public Contract Code section 9204(c)(1).
2. Claims Handling Procedure. With respect to any Contract Claim(s) sent to the County in accordance with this Section, the provisions of Public Contract Code section 9204 shall apply, and are hereby incorporated by reference into these Standard Provisions and set forth in full in *Appendix A* to these General Conditions.
3. Claims Procedure Post-Mediation. In the event mediation, if any, is unsuccessful pursuant to Public Contract Code section 9204, and all or parts of the Contract Claim(s) remain in dispute, then the Contractor shall thereafter comply with the Claim procedures as set forth below ("Claims Equal to or Less Than \$375,000") or ("Claims Exceeding \$375,000"), as applicable.

I. Claims Equal to or Less than \$375,000; Procedure

1. Application. This Section applies solely to the handling and resolution of a Contract Claim(s) that is/are in an amount equal to or less than Three Hundred Seventy-Five Thousand Dollars (\$375,000).
2. Claims Handling Procedure. With respect to any Contract Claim(s) subject to this section, the provisions of Public Contract Code section 20104, et seq. shall apply, and are hereby incorporated by reference into these Standard Provisions and set forth in full in *Appendix B* to these General Conditions.

3. Agreement to Opt-Out. Notwithstanding anything to the contrary in the Contract Documents, the County and Contractor may mutually agree at any time, in writing, that any Claim(s) to which the obligations set forth in this Section apply (i.e., unresolved Claims in an amount equal to or less than \$375,000) shall be subject to the dispute resolution requirements as set forth below applicable to the resolution and handling of claims in an amount in excess of \$375,000. Should the County and Contractor so agree in writing, the County and Contractor shall follow the requirements with respect to mediation and, if necessary, litigation, in accordance with Section J below.
- J. Contract Work Pending Claim Resolution. In the event of any dispute between the County and Contractor, or during the pendency of any Contract Claim(s) or associated proceedings under this Section or the Contract Documents, Contractor shall not stop, or delay performance of, the Work, but shall prosecute the Work diligently to completion in the manner directed by the County.
- K. Disputes Involving Architect or Design Professionals. In the event that any Claim(s) asserted by the Contractor arise from or is/are related, in any manner, to conduct or actions for which the Architect or other design professional may be responsible, the County and Contractor acknowledge and agree that the County may, in its sole discretion, require the participation and/or joinder of the Architect or other design professional in any dispute proceeding under this Section. This right shall remain solely within the discretion of the County, and Contractor shall have no rights under the Contract Documents to require or seek to compel the participation and/or joinder of the Architect or other design professional in any dispute proceeding under this Section or elsewhere under the Contract Documents.
- L. Application of Section. The procedures and remedies set forth in this Section shall not apply to: (i) any claim by the County against the Contractor or its surety or sureties (unless the County, in its sole discretion, opts to proceed hereunder); (ii) any claim or dispute relating to stop notices; or (iii) any claim relating to the approval, refusal to approve or substitution of any subcontractor, regardless of tier, pursuant to Public Contract Code section 4700, et seq.
- GC 52. HAZARDOUS MATERIALS AND / OR DIGGING TRENCHES
- A. The following requirements shall be applicable to the Project in the event that the Contractor encounters hazardous materials and/or the Work involves digging trenches or excavations that extend deeper than four feet below the surface:
- B. The Contractor shall promptly, and before the following conditions are disturbed, notify the local public entity, in writing, of any: (1) Material that the contractor believes may be material that is hazardous waste, as defined in Section 25117 of the Health and Safety Code, that is required to be removed to a Class I, Class II, or Class III disposal site in accordance with provisions of existing law. (2) Subsurface or latent physical conditions at the site differing from those indicated by information about the site made available to bidders prior to the deadline for submitting bids. (3) Unknown physical conditions at the site of any unusual nature, different materially from those ordinarily encountered and generally recognized as inherent in work of the character provided for in the contract.
- C. Upon receipt of notice from the Contractor, the County shall promptly investigate the conditions, and if it finds that the conditions do materially so differ, or do involve hazardous waste, and cause a decrease or increase in the contractor's cost of, or the time required for, performance of any part of the Work shall issue a change order under the procedures described in the contract.
- D. In the event that a dispute arises between the County and the Contractor whether the conditions materially differ, or involve hazardous waste, or cause a decrease or increase in the Contractor's cost of, or time required for, performance of any part of the Work, the Contractor shall not be excused from any scheduled completion date provided for by the contract, but shall proceed with all work to be performed under the contract. The Contractor shall retain any and all rights provided either by contract or by law which pertain to the resolution of disputes and protests between the

contracting parties. Contractor has no right to an adjustment in Contract Time or Price after acceptance of final payment.

GC 53. NONDISCRIMINATION

- A. During the performance of this contract, the Contractor and its subcontractors shall not deny the Contract's benefits to any person on the basis of religion, color, ethnic group identification, sex, age, physical or mental disability, nor shall they unlawfully discriminate, harass or allow harassment, against any employee or applicant for employment because of sex, race, color, ancestry, religious creed, national origin, disability (including HIV and AIDS), medical condition (cancer), age (over 40), marital status, denial of family care leave and denial of pregnancy disability leave in connection with any program or activity funded in whole or in part by Federal and/or State funds provided through this grant contract.
- B. Contractor and all subcontractors shall insure that the evaluation and treatment of their employees and applicants for employment are free from such discrimination and harassment. Contractor and subcontractors shall comply with the provisions of the Fair Employment and Housing Act (Government Code, Section 12990 [a-f] et seq.) and the applicable regulations promulgated thereunder (California Code of Regulations, Title 2, Section 7285.0 et seq.).
- C. The applicable regulations of the Fair Employment and Housing Commission implementing Government Code, Section 12990 (a-f), set forth in Chapter 5 of Division 4 of Title 2 of the California Code of Regulations are incorporated into this Contract by reference and made a part hereof as set forth in full. Contractor and subcontractors shall give written notice of their obligations under this clause to labor organizations with which they have a collective bargaining or other agreement.
- D. Contractor shall comply with all applicable nondiscrimination laws and regulations.
- E. The Contractor and all subcontractors shall include the nondiscrimination and compliance provisions of this clause in all contracts and subcontracts to perform work under the contract.

GC 54. RESPONSIBILITY FOR COMPLIANCE WITH OSHA

- A. All work, materials, work safety procedures and equipment shall be in full accordance with the latest OSHA rules and regulations.
- B. Contractor warrants that Contractor and each of its subcontractors shall, in performance of this Contract, comply with each and every compliance order issued pursuant to OSHA and CAL-OSHA. The Contractor assumes full and total responsibility for compliance with OSHA and CAL-OSHA Standards by its subcontractors as well as itself. The cost of complying with any compliance order and/or payment of any penalty assessed pursuant to OSHA and CAL-OSHA shall be borne by the Contractor. Contractor shall save, keep and hold harmless the Owner and all officers, employees and agents thereof from all liabilities, costs or expenses in law or in equity, that may at any time arise or be set up because of Contractor's or subcontractor's non-compliance or alleged non-compliance with OSHA and CAL-OSHA requirements.
- C. Nothing contained herein shall be deemed to prevent the Contractor and its subcontractors from otherwise allocating between themselves responsibility for compliance with OSHA and CAL-OSHA requirements; provided, however, that the Contractor shall not thereby be, in any manner whatsoever, relieved of its responsibility to the Owner as herein above set forth.

GC 55. NUCLEAR FREE HUMBOLDT COUNTY ORDINANCE COMPLIANCE

Neither the Contractor or its subcontractors or their suppliers are Nuclear Weapons Contractors and are not knowingly or intentionally engaged in the research, development, production, or testing of nuclear warheads, nuclear weapons systems, or nuclear weapons components, as defined by the Nuclear Free Humboldt County Ordinance. Contractor and its subcontractors and/or their suppliers agree to notify Owner immediately if they become a nuclear weapons contractor as defined above.

GC 56. DISCOVERY OF HUMAN REMAINS OR AN ARCHAEOLOGICAL SITE

- A. If cultural materials (e.g., chipped or ground stone, historic debris, building foundations, or bone) are discovered during ground-disturbance activities, work within 20 meters (66 feet) of the discovery shall be stopped, in accordance with Title 14 CCR 15064.5 [f]). The Owner's Representative will retain a professional archaeologist who meets the Secretary of the Interior's Standards and Guidelines to evaluate the materials and offer recommendations for further action. In addition, if Native American archaeological remains are inadvertently encountered, the Owner's Representative will notify the Tribal Historic Preservation Officers of the tribes which are traditionally and culturally affiliated with the geographic area of the project. The affected tribes will be provided the opportunity to observe the findings in the field and make recommendations for further action. Work near the archaeological find(s) shall not resume until the Owner's Representative provides notice that the required consultations have been performed.
- B. If human remains are discovered during project construction, work within 20 meters (66 feet) of the discovery location, and within any nearby area reasonably suspected to overlie human remains, will cease (in accordance with Public Resources Code, Section 7050.5). The Humboldt County Coroner will be contacted to determine if the cause of death must be investigated. If the coroner determines that the remains are of Native American origin, it is necessary to comply with state laws regarding the disposition of Native American burials, which fall within the jurisdiction of the California Native American Heritage Commission (NAHC) (Public Resources Code, Section 5097). In this case, the coroner will contact NAHC. The descendants or most likely descendants of the deceased will be contacted. Work shall not resume until the descendants or most likely descendants have made a recommendation to the Owner's Representative for excavation work with direction regarding appropriate means of treatment and disposition, with appropriate dignity, of the human remains and any associated grave goods, as provided in Public Resources Code, Section 5097.98.

GC 57. CONTRACTOR RESPONSIBILITY AND DEBARMENT

- A. A responsible contractor is a contractor who has demonstrated the attribute of trustworthiness, as well as quality, fitness, capacity and experience to satisfactorily perform the contract. It is the County's policy to conduct business only with responsible contractors. (Ord. 2291, § 1, 01/07/2003)
- B. The Contractor is hereby notified that, in accordance with Title II, Division 14 of the County Code, if the County acquires information concerning the performance of the Contractor on this or other contract which indicates that the Contractor is not responsible, the County may, in addition to other remedies provided in the contract, debar the Contractor from bidding on County contracts for a specified period of time, not to exceed three (3) years, and terminate any or all existing contracts the Contractor may have with the County. (Ord. 2291, § 1, 01/07/2003)
- C. The County may debar a contractor if the Board of Supervisors finds, in its discretion, that the contractor has done any of the following: (1) violated any term of a contract with the County; (2) committed any act or omission which negatively reflects on the contractor's quality, fitness, or capacity to perform a contract with the County or any other public entity, or engaged in a pattern or practice which negatively reflects on same; (3) committed an act or offense which indicates a lack of business integrity or business honesty; or (4) made or submitted a false claim against the County or any other public entity. (Ord. 2291, § 1, 01/07/2003)
- D. If there is evidence that the Contractor may be subject to debarment, the department will notify the Contractor in writing of the evidence which is the basis for the proposed debarment and will advise the Contractor of the scheduled date for a debarment hearing before the CHB (Contractor's Hearing Board). (Ord. 2291, § 1, 01/07/2003)
- E. The CHB will conduct a hearing where evidence on the proposed debarment is presented. The Contractor and/or the Contractor's representative shall be given an opportunity to submit evidence at

that hearing. After the hearing, the CHB shall prepare a proposed decision, which shall contain a recommendation regarding whether the Contractor should be debarred, and, if so, the appropriate length of time of the debarment. If the Contractor fails to avail itself of the opportunity to submit evidence to the CHB, the Contractor may be deemed to have waived all rights of appeal. (Ord. 2291, § 1, 01/07/2003)

- F. A record of the hearing, the proposed decision and any other recommendation of the CHB shall be presented to the Board of Supervisors. The Board of Supervisors shall have the right to modify, deny or adopt the proposed decision and recommendation of the hearing board. (Ord. 2291, § 1, 01/07/2003)
- G. These terms shall also apply to subcontractors and subconsultants of County contractors. (Ord. 2291, § 1, 01/07/2003)

APPENDIX A: CLAIMS RELATING TO PUBLIC CONTRACTS:

Public Contract Code - §9204 - Legislative findings and declarations regarding timely and complete payment of contractors for public works projects; claims process:

(a) The Legislature finds and declares that it is in the best interests of the state and its citizens to ensure that all construction business performed on a public works project in the state that is complete and not in dispute is paid in full and in a timely manner.

(b) Notwithstanding any other law, including, but not limited to, Article 7.1 (commencing with Section 10240) of Chapter 1 of Part 2, Chapter 10 (commencing with Section 19100) of Part 2, and Article 1.5 (commencing with Section 20104) of Chapter 1 of Part 3, this section shall apply to any claim by a contractor in connection with a public works project.

(c) For purposes of this section:

(1) "Claim" means a separate demand by a contractor sent by registered mail or certified mail with return receipt requested, for one or more of the following:

(A) A time extension, including, without limitation, for relief from damages or penalties for delay assessed by a public entity under a contract for a public works project.

(B) Payment by the public entity of money or damages arising from work done by, or on behalf of, the contractor pursuant to the contract for a public works project and payment for which is not otherwise expressly provided or to which the claimant is not otherwise entitled.

(C) Payment of an amount that is disputed by the public entity.

(2) "Contractor" means any type of contractor within the meaning of Chapter 9 (commencing with Section 7000) of Division 3 of the Business and Professions Code who has entered into a direct contract with a public entity for a public works project.

(3)(A) "Public entity" means, without limitation, except as provided in subparagraph (B), a state agency, department, office, division, bureau, board, or commission, the California State University, the University of California, a city, including a charter city, county, including a charter county, city and county, including a charter city and county, district, special district, public authority, political subdivision, public corporation, or nonprofit transit corporation wholly owned by a public agency and formed to carry out the purposes of the public agency.

(B) "Public entity" shall not include the following:

(i) The Department of Water Resources as to any project under the jurisdiction of that department.

(ii) The Department of Transportation as to any project under the jurisdiction of that department.

(iii) The Department of Parks and Recreation as to any project under the jurisdiction of that department.

(iv) The Department of Corrections and Rehabilitation with respect to any project under its jurisdiction pursuant to Chapter 11 (commencing with Section 7000) of Title 7 of Part 3 of the Penal Code.

(v) The Military Department as to any project under the jurisdiction of that department.

(vi) The Department of General Services as to all other projects.

(vii) The High-Speed Rail Authority.

(4) "Public works project" means the erection, construction, alteration, repair, or improvement of any public structure, building, road, or other public improvement of any kind.

(5) "Subcontractor" means any type of contractor within the meaning of Chapter 9 (commencing with Section 7000) of Division 3 of the Business and Professions Code who either is in direct contract with a contractor or is a lower tier subcontractor.

(d)(1)(A) Upon receipt of a claim pursuant to this section, the public entity to which the claim applies shall conduct a reasonable review of the claim and, within a period not to exceed 45 days, shall provide the claimant a written statement identifying what portion of the claim is disputed and what portion is undisputed. Upon receipt of a claim, a public entity and a contractor may, by mutual agreement, extend the time period provided in this subdivision.

(B) The claimant shall furnish reasonable documentation to support the claim.

(C) If the public entity needs approval from its governing body to provide the claimant a written statement identifying the disputed portion and the undisputed portion of the claim, and the governing body does not meet within the 45 days or within the mutually agreed to extension of time following receipt of a claim sent by registered mail or certified mail, return receipt requested, the public entity shall have up to three days following the next duly publicly noticed meeting of the governing body after the 45-day period, or extension, expires to provide the claimant a written statement identifying the disputed portion and the undisputed portion.

(D) Any payment due on an undisputed portion of the claim shall be processed and made within 60 days after the public entity issues its written statement. If the public entity fails to issue a written statement, paragraph (3) shall apply.

(2)(A) If the claimant disputes the public entity's written response, or if the public entity fails to respond to a claim issued pursuant to this section within the time prescribed, the claimant may demand in writing an informal conference to meet and confer for settlement of the issues in dispute. Upon receipt of a demand in writing sent by registered mail or certified mail, return receipt requested, the public entity shall schedule a meet and confer conference within 30 days for settlement of the dispute.

(B) Within 10 business days following the conclusion of the meet and confer conference, if the claim or any portion of the claim remains in dispute, the public entity shall provide the claimant a written statement identifying the portion of the claim that remains in dispute and the portion that is undisputed. Any payment due on an undisputed portion of the claim shall be processed and made within 60 days after the public entity issues its written statement. Any disputed portion of the claim, as identified by the contractor in writing, shall be submitted to nonbinding mediation, with the public entity and the claimant sharing the associated costs equally. The public entity and claimant shall mutually agree to a mediator within 10 business days after the disputed portion of the claim has been identified in writing. If the parties cannot agree upon a mediator, each party shall select a mediator and those mediators shall select a qualified neutral third party to mediate with regard to the disputed portion of the claim. Each party shall bear the fees and costs charged by its respective mediator in connection with the selection of the neutral mediator. If mediation is unsuccessful, the parts of the claim remaining in dispute shall be subject to applicable procedures outside this section.

(C) For purposes of this section, mediation includes any nonbinding process, including, but not limited to, neutral evaluation or a dispute review board, in which an independent third party or board assists the parties in dispute resolution through negotiation or by issuance of an evaluation. Any mediation utilized shall conform to the timeframes in this section.

(D) Unless otherwise agreed to by the public entity and the contractor in writing, the mediation conducted pursuant to this section shall excuse any further obligation under Section 20104.4 to mediate after litigation has been commenced.

(E) This section does not preclude a public entity from requiring arbitration of disputes under private

arbitration or the Public Works Contract Arbitration Program, if mediation under this section does not resolve the parties' dispute.

(3) Failure by the public entity to respond to a claim from a contractor within the time periods described in this subdivision or to otherwise meet the time requirements of this section shall result in the claim being deemed rejected in its entirety. A claim that is denied by reason of the public entity's failure to have responded to a claim, or its failure to otherwise meet the time requirements of this section, shall not constitute an adverse finding with regard to the merits of the claim or the responsibility or qualifications of the claimant.

(4) Amounts not paid in a timely manner as required by this section shall bear interest at 7 percent per annum.

(5) If a subcontractor or a lower tier subcontractor lacks legal standing to assert a claim against a public entity because privity of contract does not exist, the contractor may present to the public entity a claim on behalf of a subcontractor or lower tier subcontractor. A subcontractor may request in writing, either on his or her own behalf or on behalf of a lower tier subcontractor, that the contractor present a claim for work which was performed by the subcontractor or by a lower tier subcontractor on behalf of the subcontractor. The subcontractor requesting that the claim be presented to the public entity shall furnish reasonable documentation to support the claim. Within 45 days of receipt of this written request, the contractor shall notify the subcontractor in writing as to whether the contractor presented the claim to the public entity and, if the original contractor did not present the claim, provide the subcontractor with a statement of the reasons for not having done so.

(e) The text of this section or a summary of it shall be set forth in the plans or specifications for any public works project that may give rise to a claim under this section.

(f) A waiver of the rights granted by this section is void and contrary to public policy, provided, however, that (1) upon receipt of a claim, the parties may mutually agree to waive, in writing, mediation and proceed directly to the commencement of a civil action or binding arbitration, as applicable; and (2) a public entity may prescribe reasonable change order, claim, and dispute resolution procedures and requirements in addition to the provisions of this section, so long as the contractual provisions do not conflict with or otherwise impair the timeframes and procedures set forth in this section.

(g) This section applies to contracts entered into on or after January 1, 2017.

(h) Nothing in this section shall impose liability upon a public entity that makes loans or grants available through a competitive application process, for the failure of an awardee to meet its contractual obligations.

(i) This section shall remain in effect only until January 1, 2027, and as of that date is repealed, unless a later enacted statute, that is enacted before January 1, 2027, deletes or extends that date.

APPENDIX B: CLAIMS EQUAL TO OR LESS THAN \$375,000:

Public Contract Code - §20104 - Application of article; provisions included in Plans and Specifications:

(a)(1) This article applies to all public works claims of three hundred seventy-five thousand dollars (\$375,000) or less which arise between a contractor and local agency.

(2) This article shall not apply to any claims resulting from a contract between a contractor and a public agency when the public agency has elected to resolve any disputes pursuant to Article 7.1 (commencing with §10240) of Chapter 1 of Part 2.

(b)(1) "Public work" means "public works contract" as defined in Section 1101 but does not include any work or improvement contracted for by the state or the Regents of the University of California.

(2) "Claim" means a separate demand by the contractor for (A) a time extension, (B) payment of money or damages arising from work done by, or on behalf of, the contractor pursuant to the contract for a public work and payment of which is not otherwise expressly provided for or the claimant is not otherwise entitled to, or (C) an amount the payment of which is disputed by the local agency.

(c) The provisions of this article or a summary thereof shall be set forth in the plans or specifications for any work which may give rise to a claim under this article.

(d) This article applies only to contracts entered into on or after January 1, 1991.

Public Contract Code - §20104.2 - Claims; requirements; tort claims excluded:

(a) The claim shall be in writing and include the documents necessary to substantiate the claim. Claims must be filed on or before the date of Final Payment. Nothing in this subdivision is intended to extend the time limit or supersede notice requirements otherwise provided by contract for the filing of claims.

(b)(1) For claims of less than fifty thousand dollars (\$50,000), the local agency shall respond in writing to any written claim within 45 Days of receipt of the claim, or may request, in writing, within 30 Days of receipt of the claim, any additional documentation supporting the claim or relating to defenses to the claim the local agency may have against the claimant.

(2) If additional information is thereafter required, it shall be requested and provided pursuant to this subdivision, upon mutual agreement of the local agency and the claimant.

(3) The local agency's written response to the claim, as further documented, shall be submitted to the claimant within 15 Days after receipt of the further documentation or within a period of time no greater than that taken by the claimant in producing the additional information, whichever is greater.

(c)(1) For claims of over fifty thousand dollars (\$50,000) and less than or equal to three hundred seventy-five thousand dollars (\$375,000), the local agency shall respond in writing to all written claims within 60 Days of receipt of the claim, or may request, in writing, within 30 Days of receipt of the claim, any additional documentation supporting the claim or relating to defenses to the claim the local agency may have against the claimant.

(2) If additional information is thereafter required, it shall be requested and provided pursuant to this subdivision, upon mutual agreement of the local agency and the claimant.

(3) The local agency's written response to the claim, as further documented, shall be submitted to the claimant within 30 Days after receipt of the further documentation, or within a period of time no greater than that taken by the claimant in producing the additional information or requested documentation, whichever is greater.

(d) If the claimant disputes the local agency's written response, or the local agency fails to respond within the time prescribed, the claimant may so notify the local agency, in writing, either within 15 Days of receipt of the local agency's response or within 15 Days of the local agency's failure to respond within the time prescribed, respectively, and demand an informal conference to meet and confer for settlement of the issue in dispute. Upon a demand, the local agency shall schedule a meet and confer conference within 30 Days for settlement of the dispute.

(e) Following the meet and confer conference, if the claim or any portion remains in dispute, the claimant may file a claim as provided in Chapter 1 (commencing with §900) and Chapter 2 (commencing with §910) of Part 3 of Division 3.6 of Title 1 of the Government Code. For purposes of those provisions, the running of the period of time within which a claim must be filed shall be tolled from the time the claimant submits his or her written claim pursuant to subdivision (a) until the time that claim is denied as a result of the meet and confer process, including any period of time utilized by the meet and confer process.

(f) This article does not apply to tort claims and nothing in this article is intended nor shall be construed to change the time periods for filing tort claims or actions specified by Chapter 1 (commencing with §900) and Chapter 2 (commencing with §910) of Part 3 of Division 3.6 of Title 1 of the Government Code.

Public Contract Code - § 20140.4 - Civil action procedures; mediation and arbitration; trial de novo; witnesses:

(a) Within 60 Days, but no earlier than 30 Days, following the filing or responsive pleading, the court shall submit the matter to nonbinding mediation unless waived by mutual stipulation of both parties. The mediation process shall provide for the selection within 15 Days by both parties of a disinterested third person as mediator, shall be commenced within 30 Days of the submittal, and shall be concluded within 15 Days from the commencement of the mediation unless a time requirement is extended upon a good cause showing to the court or by stipulation of both parties. If the parties fail to select a mediator within the 15-Day period, any party may petition the court to appoint the mediator.

(b)(1) If the matter remains in dispute, the case shall be submitted to judicial arbitration pursuant to Chapter 2.5 (commencing with §1141.10) of Title 3 of Part 3 of the code of Civil Procedure, notwithstanding § 1141.11 of that code. The Civil Discovery Act (Title 4 (commencing with §2016.010) of Part 4 of the Code of Civil Procedure) shall apply to any proceeding brought under this subdivision consistent with the rules pertaining to judicial arbitration.

(2) Notwithstanding any other provision of law, upon stipulation of the parties, arbitrators appointed for purposes of this article shall be experienced in construction law, and, upon stipulation of the parties, mediators and arbitrators shall be paid necessary and reasonable hourly rates of pay not to exceed their customary rate, and such fees and expenses shall be paid equally by the parties, except in the case of arbitration where the arbitrator, for good cause, determines a different division. In no event shall these fees or expenses be paid by state or county funds.

(3) In addition to Chapter 2.5 (commencing with § 1141.10) of Title 3 of Part 3 of the Code of Civil Procedure, any party who after receiving an arbitration award requests a trial de novo but does not obtain a more favorable judgment shall, in addition to payment of costs and fees under that chapter, pay the attorney's fees of the other party arising out of the trial de novo.

(c) The court may, upon request by any party, order any witnesses to participate in the mediation or arbitration process.

Public Contract Code - §20140.6 - Payment on undisputed portion of claim; interest on arbitration awards or judgments:

(a) No local agency shall fail to pay money as to any portion of a claim which is undisputed except as otherwise provided in the contract.

(b) In any suit filed under § 20104.4, the local agency shall pay interest at the legal rate on any arbitration award or judgment. The interest shall begin to accrue on the date the suit is filed in a court of law.

END OF SECTION 00 72 00

SUPPLEMENTARY GENERAL CONDITIONS

SGC 1. SUPERVISORY SECURITY CLEARANCES

Prior to Admittance and any work, CONTRACTOR and all employees who will enter the Correctional Facility shall be responsible for filling out a "Facility Clearance Application Form" and submitting it to the Administrative Staff. Forms are available upon request at the Administrative Offices on the Second Floor of the Correctional Facility. Once complete, CONTRACTOR may obtain a copy of the pre-approved list from the same Second Floor Administrative Offices location. Only those individuals on the pre-approved list will be allowed to enter the premises.

SGC 2. SECURITY BADGES

The Contractor shall be responsible for obtaining security badges for themselves and all construction personnel who will enter the Correctional Facility from the Duty Shift Supervisor in Processing. All security badges shall be logged and returned to the Correctional Facility upon completion of work, portions of work, or close of shift as indicated on phasing plans.

SGC 3. The California State Public Works Board (SPWB) and the Board of State and Community Corrections (BSCC) and their respective officers, agents, and employees shall be included as additional insured in all insurance required in GC 4. Insurance Requirements.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Contractor's use of site and premises.
- B. County-furnished, Contractor-installed (OFCI) items.
- C. County's occupancy requirements.
- D. Specification formats and conventions.

1.2 CONTRACTOR'S USE OF SITE AND PREMISES

- A. Coordinate use of the premises under the direction of the County.
- B. Assume full responsibility for the protection and safekeeping of materials, products, and equipment under this Contract, stored on the site.
- C. Move any stored materials, products, and equipment under Contractor's control which interfere with the operations of County or a separate contractor.
- D. Obtain and pay for the use of additional storage or work areas needed for Contractor's operations.
- E. Contractor shall be aware of and abide by the Humboldt County and local Noise Ordinance and County's noise prevention requirements. Contractor to verify County's requirements.

1.3 COUNTY-FURNISHED AND CONTRACTOR-INSTALLED (OFCI) ITEMS

- A. County-Furnished and Contractor-Installed (OFCI) Items: As indicated on the Drawings and Technical Specifications.
- B. County's Responsibilities:
 - 1. County will furnish products indicated. Schedule relocation of items with County.
 - 2. After relocation, County will inspect delivered items for damage, jointly with Contractor.
- C. Contractor's Responsibilities:
 - 1. Contractor is responsible for relocating, unloading, and handling County-furnished items at Project site.
 - 2. Contractor is responsible for protecting County-furnished items from damage during storage and handling, including damage from exposure to the elements.
 - 3. Contractor shall install and incorporate County-furnished items into the Work, as indicated and as required. Work includes providing support systems to receive County's equipment and making plumbing, mechanical, electrical connections, and miscellaneous work items associated with installation of County-furnished items.
 - 4. Contractor shall repair or replace County-furnished items damaged by Contractor's operations, as approved by County in writing.
 - 5. Contractor shall furnish and install fasteners and other accessories, as required for complete installation of County-furnished items.

1.4 COUNTY'S OCCUPANCY REQUIREMENTS

- A. Full County Occupancy: County will occupy the Jail, with the exception of areas under construction, during the entire construction period to conduct normal operations.
- B. Cooperate with County to minimize conflicts, and to facilitate County's operations.
- C. Verify occupancy requirements with County, and schedule the Work to accommodate County's requirements.
- D. Maintain access to existing walkways and other adjacent occupied or used facilities. Do not close or obstruct walkways or other occupied or used facilities without written permission from County and authorities having jurisdiction.
- E. Provide not less than 72 hours' notice to County of activities that will affect County's operations.

1.5 ENVIRONMENTAL MANAGEMENT

- A. Spills: Contractor shall clean up all fluid spills caused by leaks in the equipment or generated while Contractor is performing the work under this Contract. Contractor shall provide drip catch pans for all equipment that drips or leaks oils or other fluids. Spills generated by Contractor's operation shall be cleaned up by Contractor at no cost to County.
- B. Dust and Noise Control:
 - 1. Precaution shall be exercised at all times to control dust and excessive noise created as a result of any operations during the construction period.
 - 2. If serious problems and/or complaints arise due to airborne dust and excessive noise, and when directed by the County, operations causing such problems shall be temporarily discontinued until a suitable remedy is established. The remedy shall be approved by the County before implementation, and shall be considered part of Contractor's normal effort to maintain safety and cleanliness without cause for further payment.

1.6 MATERIALS AND WORKMANSHIP

- A. Except as otherwise specified all materials and equipment incorporated in the Work under the Contract shall be new. All workmanship shall be first-class and by persons qualified in the respective trades.

1.7 ACCIDENT PREVENTION AND PROTECTION OF LIVES AND HEALTH

- A. Precaution shall be exercised at all times for protection of all personnel and occupants, including employees of Contractor, County, and property.
- B. The California Department of Industrial Relations, Division of Occupational Safety and Health (DOSH, also known as Cal/OSHA) requirements for safety and health protection of workers and public apply. Other requirements not covered by Cal/OSHA, shall be in accordance with U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) requirements.
- C. Comply with safety requirements of CCR, Title 8, Division 1, Chapter 4, "Division of Industrial Safety," and Title 8, Division 1, Chapter 3.2, "Cal/OSHA Regulations"; CCR, Title 24, CBC; and other applicable building and construction codes. Machinery, equipment, openings, power lines, and all other safety hazards shall be guarded or eliminated in accordance with

safety requirements of Title 8, and Manual of Accident Prevention in Construction published by the Associated General Contractors of America.

- D. Comply with any applicable Federal, State or Local public health orders in response to new or ongoing health pandemics, endemics or public health emergencies. Should any orders be in-place prior to, or made during the course of the Work, Contractor shall prepare and submit no later than five (5) days after it receives notice from Owner that it will be awarded a contract for the project, or within five (5) days after such order is made during the course of the Work as a condition precedent to mobilizing to the project site or continuing construction, an Exposure Prevention, Preparedness and Response Plan specific to this project that describes how to prevent worker exposure to coronavirus or other biological agent, protective measures to be taken on the jobsite, personal protective equipment and work practice controls to be used, cleaning and disinfecting procedures, and what to do if a worker(s) shows symptoms of pandemic or endemic related illness or tests positive for such biological agents. Contractor's Plan shall be consistent with and prepared in conjunction with any similar plans issued by Owner and if such plans or similar requirements impose greater obligations on Contractor, Contractor shall comply with same and revise its plan accordingly unless directed otherwise in writing by Owner. The Contractor should review the latest OSHA Workplace Safety Guidance documents that may be available in response to active pandemics or endemics (<https://www.osha.gov>) as a resource in preparation of its Site Specific Health and Safety Plan

1.8 UTILITIES

- A. Excavation at the Project site requires a call to Underground Service Alert North (USA North), 811 or by internet at <http://usanorth811.org>.
1. Contractor shall call USA North at least 7 days prior to commencing excavation work. Obtain a ticket number and confirm service date for marking underground facilities (utilities).
 2. Prior to placing the call, Contractor shall mark the outline of excavation with white chalk, white paint, or stakes, to enable representatives (locators) of USA North members to map the area for existing underground facilities (utilities).
- B. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by County or others unless permitted under the following conditions and then only after providing temporary utility services according to requirements indicated:
1. Notify the County not less than three days in advance of proposed utility interruptions.
 2. Obtain County's written permission before proceeding with utility interruptions.
- C. Provide necessary protection to existing utility services and repair work damaged as a result of operations under this Contract.

1.9 PROTECTION OF EXISTING FACILITIES

- A. Contractor shall take appropriate measures to prevent damage to existing facilities, site work, landscaping, and adjoining property. Should damage occur, such facilities, site work, landscaping, and property shall be restored to original condition, at no cost to County.
1. Contractor shall arrange for protection of existing buildings at all times. Contractor shall furnish, install, and maintain, necessary barricades, temporary coverings, etc., as required for protection, and remove them at completion of the Work. When all Work is complete, damaged areas of the premises shall be restored to original undamaged condition that existed prior to installation of temporary protection.
- B. Housekeeping: The premises shall be kept in a clean, safe condition at all times. Rubbish shall be removed as fast as it accumulates, but not less than one time per day.

- C. Burning: Burning of refuse, debris, and construction waste at Project site will not be permitted.

1.10 OVERLOADING

- A. Contractor shall not overload any part or parts of structures beyond their safe calculated carrying capacities by placing materials, equipment, tools, machinery or any other item thereon. No loads shall be placed on floors or roofs before they have attained their permanent and safe strength.

1.11 MANUFACTURER'S INSTRUCTIONS

- A. Where required in the Specifications that materials, products, equipment, and processes be installed or applied in accordance with manufacturer's instructions, directions, or specifications, or stated in words to that effect, it shall be construed to mean that said installation or application shall be in strict accordance with printed instructions furnished by manufacturer of the specified item and is suitable for use under conditions similar to those at the jobsite. Three copies of such instructions shall be included in the applicable submittal and furnished to the County for review. Obtain County's acceptance prior to commencement of the Work.

1.12 RESPONSIBILITY FOR THEFT AND DAMAGE

- A. County will not be responsible for the loss or theft of Contractor's tools, equipment and materials.

1.13 FIRE PROTECTION

- A. Contractor shall at all times maintain good housekeeping practices to reduce the risk of fire and water damage. All scrap materials, rubbish and trash shall be removed daily from jobsite, inside and around the buildings or structures, as applicable, and shall not be scattered on adjacent property.
- B. Suitable storage space shall be provided outside immediate building areas during construction for temporary storage of flammable materials and paints, as required by CFC Chapter 14 and NFPA 241. Excess flammable liquids being used inside the building shall be kept in closed metal containers and be removed from the building during unused periods.
- C. Contractor shall provide temporary fire extinguishers during construction in accordance with the recommendations of CBC Chapter 33, CFC Chapter 14, and NFPA 10 and Bulletin No.241. However, in all cases a minimum of one fire extinguisher shall be available for use.
- D. Under provisions of CFC Chapters 14 and 26, provide a fire extinguisher at each location where cutting, soldering, or welding is being performed. Where electric or gas welding or cutting work is done, interposed shields of noncombustible material shall be used to protect against fire damage due to sparks and hot metal. When temporary heating devices are used, a watchman shall be present to cover periods when other workmen are not on the premises.

1.14 EMERGENCY CONDITIONS

- A. Emergency condition shall be any condition at the Project site which has the actual or potential for significant adverse effects to persons or property, whether or not resulting from Contractor's operations.
- B. Immediate action shall be taken by Contractor by whatever means necessary to alleviate the

condition and to prevent damage or injury to persons or property. County shall be notified of the existence of such a condition, but shall not be called upon to perform emergency service.

- C. County may not respond to the emergency condition, which shall not be used as an excuse by Contractor to neglect immediate action; County will not be responsible or liable for any resulting conditions. Absence of Contractor's Representative during emergency conditions at jobsite shall not relieve Contractor from contractual responsibility of providing an immediate response to the situation, for restoration of conditions to normalcy.
- D. If the emergency conditions are not caused by Contractor's fault or neglect, the Contract Sum shall be adjusted to reflect the actual direct field costs of labor and materials to perform and complete emergency measures.
- E. The Contract Time shall also be adjusted to reflect the actual direct effect of such actions to the then critical path of the Construction Progress Schedule. The foregoing notwithstanding, adjustments of the Contract Sum or the Contract Time for actions taken by Contractor in response to emergency circumstances shall be subject to Contractor's strict compliance with all other applicable provisions of the Contract Documents relating to notices and time for delivery of notices.

1.15 SPECIFICATION FORMATS AND CONVENTIONS

- A. Specification Format: The Specifications are organized into Divisions and Sections using the 48-division format and numbering system of CSI "MasterFormat, 2016 Edition.
- B. Division 01 Sections govern the execution of the Work of all Sections in the Specifications.
- C. Specifications Conventions: Singular words shall be interpreted as plural and plural words shall be interpreted as singular, where applicable, as the context of the Contract Documents indicates.
- D. These specifications are written in imperative mood and streamlined form. This imperative language is directed to the Contractor, unless specifically noted otherwise. The words "shall be" are included by inference where a colon (:) is used within sentences or phrases.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Coordination of construction operations.
- B. Field engineering.
- C. Electronic File Availability

1.2 COORDINATION

- A. Coordinate scheduling, submittals and Work of various Sections of the Contract Documents to ensure efficient and orderly sequence of installation of interdependent construction elements, with provisions for accommodating items installed later.
- B. In the event of discrepancy, immediately notify the County. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.
- C. Verify that utility requirement characteristics of operating equipment are compatible with building utilities. Coordinate work of various Sections having interdependent responsibilities for installing, connecting to, and placing operating equipment in service.
- D. Coordinate space requirements and installation of mechanical and electrical work which are indicated diagrammatically on Drawings. Follow routing shown for pipes, ducts and conduit, as closely as practicable; place runs parallel with line of building. Utilize spaces efficiently to maximize accessibility for installation of other Work, maintenance work, and repair work.
- E. Do not use spray paint or indelible ink markers for layout on concrete floor slabs scheduled to receive sealed concrete, stained concrete, vinyl, linoleum, or rubber flooring.
- F. In finished areas except as otherwise indicated, conceal pipes, ducts, and wiring within the construction. Coordinate locations of fixtures and outlets with finish elements.
- G. Coordinate completion and cleanup of Work of separate Sections in preparation for Final Completion.
- H. After beneficial occupancy of premises by the County, coordinate access to site for correction of defective Work and Work not complying with the Contract Documents, and to minimize disruption of County's activities.

1.3 FIELD ENGINEERING

- A. Employ Land Surveyor registered in the State of California and acceptable to the County.
- B. Locate and protect survey control and reference points. Promptly notify the County of discrepancies discovered.
- C. Control datum for survey is as shown on Drawings.
- D. Verify setbacks and easements; confirm Drawing dimensions and elevations.
- E. Provide field-engineering services. Establish elevations, lines, and levels, utilizing

recognized engineering survey practices.

- F. Submit copies of site drawing and certificate signed by Land Surveyor certifying elevations and locations of the Work are in conformance with the Contract Documents.
- G. Maintain complete and accurate log of control and survey work as Work progresses.
- H. On completion of foundation walls and major site improvements, prepare certified survey illustrating dimensions, locations, angles, and elevations of construction and site work.
- I. Protect survey control points prior to starting site work; preserve permanent reference points during construction.
- J. Promptly report to the County loss or destruction of reference point or relocation required because of changes in grades or other reasons.
- K. Replace dislocated survey control points based on original survey control. Make no changes without prior written notice to the County.

1.4 UTILITIES AND IRRIGATION LINES

- A. Send proper notices, make necessary arrangements, perform other services required in construction, care and maintenance of all utilities and irrigation lines, and assume all responsibility concerning the same. Provide necessary protection to existing utility services and irrigation lines as directed, and repair any work damaged as a result of operations of the Contract.

1.5 COMPLIANCE WITH CODE OF REGULATIONS

- A. All work and materials on this project shall be in compliance with the rules and regulations as set forth in the Title 24, CCR Parts 1 – 6, 9, and 12 which shall be kept continuously at the site of the Work until completion and final acceptance.

1.6 PROJECT COORDINATION

- A. If, because of the non-related sizes of various materials and locations of existing utilities and conditions, etc., it is not possible to accomplish the Work as shown, Contractor shall meet with County at the site to determine the most satisfactory arrangement. Contractor shall establish lines and grades for all trades.

1.7 INTEGRATING EXISTING WORK

- A. All adjoining existing Work shall be protected from damage of any type due to or by Contractor's operations, equipment, and workmen during the Contract period.

1.8 ELECTRONIC FILE AVAILABILITY

- A. Architect's electronic drawing files for this project will be available to Contractor upon written request. The request shall include the drawing sheet number of each drawing being requested. Architect shall respond to the written request using the Delivery of Electronic Files Agreement Form attached at the end of this Section. Contractor shall sign and date the form, return it to Architect prior to the electronic files being delivered to Contractor.

**NMR + LIONAKIS
ARCHITECTS**

**SECTION 01 30 00
ADMINISTRATIVE REQUIREMENTS**

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

**Terms and Conditions for
Delivery and Use of Electronic Media/Electronic Media Disclaimer**

<p>Project: _____</p> <p>NMR Project No.: _____</p> <p>Electronic Media being delivered: _____</p> <p>_____</p>
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This Agreement is made by and between Nichols, Melburg & Rossetto, Architects (hereinafter referred to as NMR) and the company identified below (hereinafter referred to as Recipient) relative to the delivery and use of electronic media for the subject project:

1. The electronic media files of selected portions of the subject project are being provided to the Recipient by NMR for use by the Recipient and Its Subcontractors in the preparation of shop drawings, coordination drawings, and related submittals specific to the subject project. The electronic media files may be used only on the subject project. No other use by the Recipient, Its Subcontractors, or others is permitted by this Agreement.
2. The delivery of these electronic media is a courtesy of NMR, on behalf of and at the request of the Recipient. In accepting and utilizing any drawings or other data on any form of electronic media generated and provided by NMR, Recipient agrees that all such drawings and data are instruments of professional service of NMR, and shall remain the property of NMR. In addition, NMR shall be deemed the author of the drawings and data, and shall retain all common law, statutory law and other rights, including copyrights.
3. The requirements of the Contract Documents for the subject project are in no way changed or modified by providing the Recipient with the electronic media files for the subject project.
4. Recipient agrees that NMR shall not be held responsible for notification to Recipient of changes, updates, or other project-related modifications that may occur after release of electronic media.
5. Electronic media drawing files, data, and other instruments of service provided by NMR contain proprietary electronic data that is provided as a convenience only. The information contained on these files shall not be "scaled" or "measured" for dimensions. All factual information shall be derived from the latest issued hard copy Contract Documents. Because NMR has no control over damage or alteration of this electronic data, it is understood that Recipient accepts all risks for its use. This data, or any part thereof, shall not be translated or reproduced in any form without the express written permission of NMR.
6. In using, modifying, or accessing information from the electronic media, Recipient is responsible for confirmation, accuracy, and checking of the data from the electronic media against data contained in the latest issued hard copy Contract Documents, as well as actual field conditions and dimensions. These electronic media are instruments of service and not a product, and any party using them shall independently verify the information contained therein. NMR does not warrant or guarantee that the electronic media files are completely accurate or free of errors.
7. Recipient agrees not to use these electronic media, in whole or in part, for any purpose or project other than the subject project. Recipient agrees to waive all claims against NMR and the County of Humboldt and all other design professionals and consultants working under consulting agreements with NMR on the subject project resulting in any way from any unauthorized use or reuse of, or changes to, these electronic media by anyone other than NMR.
8. Recipient acknowledges that use of information contained in these electronic media is at the Recipient's sole risk, and without liability, risk, or legal exposure to NMR and the County of Humboldt. Furthermore, Recipient shall, to the fullest extent permitted by law, defend, indemnify, and hold

harmless the County of Humboldt, NMR, its officers, directors, shareholders, employees, and all design professionals and consultants working under consulting agreements with NMR on the subject project, from and against any and all claims, demands, liabilities, losses, damages, penalties, and costs of any kind, including attorney's fees and costs of defense, arising out of or in any way connected with the use, reuse, modification, misrepresentation, or misuse by Recipient or third party of the electronic media provided by NMR. The foregoing indemnification also applies, without limitation, to any use of the electronic media for completion of the subject project by others, or additions to the subject project, excepting only such use as may be authorized in writing by NMR.

9. Under no circumstances shall the transfer of these electronic media for use by the Recipient and Its Subcontractors be deemed a sale by NMR, and NMR makes no warranties, either express or implied, of merchantability and fitness for any particular purpose.
10. Whenever the electronic media files are used by the Recipient's Subcontractor(s), Recipient shall communicate the contents of this Agreement in its entirety to said Subcontractor(s), and shall hold said Subcontractor(s) to all conditions noted herein for use of the electronic media. Distribution of the electronic media to Recipient's Subcontractor(s) shall be done through the Recipient. Any and all inquiries from Recipient's Subcontractors related to these electronic media shall be routed through Recipient.

Please acknowledge your acceptance of these conditions by signing below and returning the original to NMR.

Submitted By: _____ Recipient: _____

By: _____ By: _____
Printed Name / Title Printed Name / Title

Signed: _____ Signed: _____
Authorized Signature Authorized Signature

Date: _____ Date: _____

END OF SECTION

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
 - a. General coordination procedures.
 - b. Coordination drawings.
 - c. Project Meetings.
- B. Each contractor shall participate in coordination requirements. Certain areas of responsibility are assigned to a specific contractor.

1.2 SUBMITTALS

- A. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. This list shall include all subcontractors including those with work of a value less than one-half of one percent of the agreement price. Include the following information in tabular form:
 - 1. Name, address, and telephone number of entity performing subcontract or supplying products.
 - 2. Number and title of related Specification Section(s) covered by subcontract.
 - 3. Drawing number and detail references, as appropriate, covered by subcontract.
- B. Key Personnel Names: Within 15 days of starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project Site. Identify individuals and the duties and responsibilities; list address, telephone numbers, (Home, office, and cellular) and email addresses. Provide names, addresses, and telephone numbers of individuals assigned as alternates in the absence of individuals assigned to Project.
 - 1. Post copies of list in project meeting room, in temporary field office, and by each temporary telephone. Keep list current at all times.

1.3 COORDINATION PROCEDURES

- A. Coordination: Coordinate construction operations to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations that depend on each other for proper installation, connection, and operation.
 - 1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
 - 2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
 - 3. Make adequate provisions to accommodate items scheduled for later installation.
- B. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include items as required notices, reports, and list of attendees at meetings.
 - 1. Prepare similar memoranda for Owner and separate contractors if coordination of the Work is required.
- C. Administrative Procedures: Coordinate scheduling and timing of required administrative

procedures with other construction activities to avoid conflicts and to ensure orderly progress of the Work. Administrative activities include, but are not limited to, the following:

1. Preparation of Contractor's construction schedule.
 2. Preparation of the schedule of values.
 3. Installation and removal of temporary facilities and controls.
 4. Delivery and processing of submittals.
 5. Progress meetings.
 6. Pre-installation conferences.
 7. Project closeout activities.
 8. Startup and adjustment of systems.
 9. Coordinating inspections and other jurisdictional requirements.
 10. Coordinate OFCI equipment.
 11. Action items and issue logs.
- D. Conservation: Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.
1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work. Refer to the Specifications Sections for disposition of salvaged materials that are designated as Owner's property.

1.4 COORDINATION DRAWINGS

- A. Coordination Drawings, General: Prepare coordination drawings according to requirements in individual Sections, and additionally where installation is not completely shown on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one entity.
1. Content: Project-specific information, drawn accurately to a scale large enough to indicate and resolve conflicts. Do not base coordination drawings on standard printed data. Include the following information, as applicable:
 - a. Use applicable Drawings as a basis for preparation of coordination drawings. Prepare sections, elevations, and details as needed to describe relationship of various systems and components.
 - b. Coordinate the addition of trade specific information to the coordination drawings by multiple contractors in sequence that best provides for coordination of the information and resolution of conflicts between installed components before submitting for review.
 - c. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
 - d. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
 - e. Show location and size of access doors required for access to concealed dampers, valves, and other controls.
 - f. Indicate required installation sequences.
 - g. Indicate dimensions shown on the Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Architect indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.
- B. Coordination Drawing Organization:
1. Floor Plans and Reflected Ceiling Plans: Show architectural and structural elements, and mechanical, plumbing, fire-protection, fire-alarm, and electrical Work. Show locations of visible ceiling-mounted devices relative to acoustical ceiling grid. Supplement plan drawings with section drawings where required to adequately

- represent the Work.
2. Plenum Space: Indicate subframing for support of ceiling and wall systems, mechanical and electrical equipment, and related Work. Locate components within ceiling plenum to accommodate layout of light fixtures indicated on Drawings. Indicate areas of conflict between light fixtures, ductwork, piping, and other components.
 3. Mechanical Rooms: Provide coordination drawings for mechanical rooms showing plans and elevations of mechanical, plumbing, fire protection, fire-alarm, and electrical equipment.
 4. Structural Penetrations: Indicate penetrations and openings required for all disciplines.
 5. Slab Edge and Embedded Items: Indicate slab edge locations and sizes and locations of embedded items for metal fabrications, sleeves, anchor bolts, bearing plates, angles, door floor closers, slab depressions for floor finishes, curbs and housekeeping pads, and similar items.
 6. Mechanical and Plumbing Work: Show the following:
 - a. Sizes and bottom elevations of ductwork, piping, and conduit runs, including insulation, bracing, flanges, and support systems.
 - b. Dimensions of major components, such as dampers, valves, diffusers, access doors, cleanouts and electrical distribution equipment.
 - c. Fire-rated enclosures around ductwork.
 7. Electrical Work: Show the following:
 - a. Runs of vertical and horizontal conduit 1-1/4 inches (32 mm) in diameter and larger.
 - b. Light fixture, exit light, emergency battery pack, smoke detector, and other fire alarm locations.
 - c. Panel board, switch board, switchgear, transformer, busway, generator, and motor control center locations.
 - d. Location of pull boxes and junction boxes, dimensioned from column center lines.
 - e. Floor boxes.
 8. Fire Protection System: Show the following:
 - a. Locations of standpipes, mains piping, branch lines, pipe drops, sprinkler heads, and inspector test locations.
 9. IDF/MDF Rooms: Communications and low voltage (security, data, phone, etc.) audio
 10. Review: Architect will review coordination drawings to confirm that the Work is being coordinated, but not for the details of the coordination, which are Contractor's responsibility. If Architect determines that coordination drawings are not being prepared in sufficient scope or detail, or are otherwise deficient, Architect will so inform Contractor, who shall make changes as directed and resubmit.
 11. Coordination Drawing Prints: Prepare coordination drawing prints according to requirements in Section 01 33 00 Submittal Procedures.
- C. Coordination Digital Data Files: Prepare coordination digital data files according to the following requirements:
1. File Preparation Format: Same digital data software program, version, and operating system as original Drawings.
 2. File Submittal Format: Submit or post coordination drawing files using format same as file preparation format.
 3. BIM File Incorporation: Develop and incorporate coordination drawing files into Building Information Model established for Project.
 - a. Perform three dimensional component conflict analysis as part of preparation of coordination drawings. Resolve component conflicts prior to submittal. Indicate where conflict resolution requires modification of design requirements by Architect.
 4. Architect will furnish Contractor one set of digital data files of Drawings for use in preparing coordination digital data files.
 - a. Architect makes no representations as to the accuracy or completeness of digital data files as they relate to Drawings.
 - b. Digital Data Software Program: Drawings are available in Revit.

- c. Contractor shall execute a data licensing agreement in the form of AIA Document C106.

1.5 PROJECT MEETINGS

- A. Schedule and conduct meetings and conferences at Project site unless otherwise indicated.
 1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Architect of scheduled meeting dates and times.
 2. Agenda: Owner's Representative to prepare the meeting agenda and distribute the agenda to all invited attendees.
 3. Minutes: Entity responsible for conducting meeting will record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner and Architect, within three days of the meeting.
 4. Action Items: An element of work, design, research, or other task to be completed before a specific date or time, such as before a subsequent meeting of involved parties.
 5. Issue logs: Documentation element of software project management and contains a list of ongoing and closed issues of the project.

- B. Kick-off & Preconstruction Conference: Owner's Representative will schedule and conduct a preconstruction conference before starting construction, at a time convenient to Owner and Architect.
 1. Conduct the conference to review responsibilities and personnel assignments.
 2. Attendees: Authorized representatives of Owner, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
 3. Agenda: Particular emphasis should be on:
 - a. Functions and authority of personnel
 - b. Regularly scheduled progress meetings
 - c. Submittals/shop drawings
 - d. Requests for Information
 - e. Field Orders
 - f. Payment Applications
 - g. Progress Schedules
 - h. Safety and Job Site Security
 - i. Change Order procedures
 - j. Subcontractors
 - k. Disputes
 - l. Quality Control
 - m. Coordination of contractors
 - n. Access and use of site.
 4. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.
 5. Action Items: An element of work, design, research, or other task to be completed before a specific date or time, such as before a subsequent meeting of involved parties.

- C. Pre-installation Conferences: Conduct a pre-installation trade conference at site before each construction activity that requires coordination with other construction trades.
 1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Architect and Engineer of Record of scheduled meeting dates.
 2. Agenda: Contractor to review progress of other construction activities and preparations

- for the particular activity under consideration.
3. Contractor to record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
 4. Reporting: Contractor to distribute minutes of the meeting to each party present and to other parties requiring information.
 5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.
 6. Action Items: An element of work, design, research, or other task to be completed before a specific date or time, such as before a subsequent meeting of involved parties.
- D. Project Closeout Conference: Schedule and conduct a project closeout conference, at a time convenient to Owner and Architect, but no later than 90 days prior to the scheduled date of Substantial Completion.
1. Conduct the conference to review requirements and responsibilities related to Substantial Completion.
 2. Attendees: Authorized representatives of Owner, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the meeting. Participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
 3. Agenda: Discuss items of significance that could affect or delay Project closeout.
 4. Minutes: Entity conducting meeting will record and distribute meeting minutes.
 5. Action Items: An element of work, design, research, or other task to be completed before a specific date or time, such as before a subsequent meeting of involved parties.
- E. Progress Meetings:
1. Attendees will include the Owner's Representative, Owner's Project Administrator, the Contractor, and the Lead Consultant. Scheduled invited Attendees will include the Architect and sub-consultants, subcontractors, and other owner personnel.
 2. The Project Administrator will prepare an agenda with content lead from the Contractor (which usually is derived from the previous meeting minutes) for discussion at these meetings. The agenda should include a list of outstanding item, which will be reviewed as appropriate. As a minimum the following will be discussed:
 - a. Construction Status
 - b. Schedule
 - i. Critical Path Activities
 - ii. Job site problems and conflicts
 - iii. Upcoming Activities
 - iv. Completion Date
 - v. Time Extension Requests
 - c. Submittals/shop drawings
 - d. Requests for Information
 - e. Field Orders
 - f. Cost Proposals
 - g. Change Orders
 - h. Safety and Security
 - i. Claims
 - j. Quality Control
- F. 3. The Project Administrator will record and distribute minutes of the meeting to all attendees in a timely manner in order to allow review before the next regularly scheduled meeting.
4. In addition to the ongoing items of discussion listed above, time should be reserved to

review any unresolved issues. Any representative attending the meeting may introduce these. Control logs for RFI's, submittals, and Cost Proposals should be discussed in the meeting.

- G. Pay Request Meetings:
 - 1. A regularly scheduled monthly meeting to review the pay request will be established.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

PART 1 GENERAL

1.1 SUMMARY

- A. General: This Section specifies administrative and procedural requirements for the critical path method (CPM) of scheduling and reporting progress of the Work.

1.2 DESCRIPTION

- A. Requirements for CPM scheduling are included to insure adequate planning and execution of the Work and to assist the County in evaluating progress of the Work economically and chronologically.
- B. The Contractor shall be solely responsible for establishing the schedule for the Work and shall be responsible for such schedule to be consistent with meeting the contract milestone, intermediate milestones, and completion dates as established by the County.
 - 1. The Contractor shall develop a CPM Schedule demonstrating fulfillment of all contract requirements. The project schedule shall be kept current to be utilized for scheduling, coordinating, monitoring work progress, and for preparation of the monthly payment application for payment under this Contract including all Work of Subcontractors and equipment and material suppliers.
 - 2. Schedule shall include activities pertaining to long lead delivery items, fabrication items and submittal of shop drawings and product samples, and any items critical to maintaining all activities in the CPM.
- C. Contractor shall designate a scheduler who is trained and experienced in compiling construction scheduling data, in analyzing scheduling data by use of CPM, and in the preparation and issuance of periodic reports as required herein. The Contractor's Scheduling Representative shall have direct control and complete authority to act on behalf of the Contractor in fulfilling all project schedule requirements.

1.3 QUALITY ASSURANCE

- A. The following publication is cited as reference for CPM and scheduling techniques utilized in this Contract:

J.J. Moder & C.R. Phillips, Project Management with CPM & Pert.
New York: Reinhold Publishing Corp.

1.4 INITIAL CONSTRUCTION SCHEDULE

- A. Pre-Construction Scheduling Conference: The Contractor and County shall conduct a pre-construction scheduling conference with the Contractor's Project Manager and Construction Scheduler within five calendar days of the Notice to Proceed.
 - 1. The Contractor shall submit a general time-scaled logic diagram displaying the major activities and sequence of planned operations and shall be prepared to discuss the proposed work plan and schedule methodology that comply with the requirements of these special provisions . Contractor shall submit the alphanumeric coding structure and the activity identification system for labeling the Work activities.
 - 2. The County will review the logic diagram, coding structure, and activity identification system, and provide required baseline schedule changes to the Contractor for implementation.
- B. Within 10 calendar days after Notice to Proceed and prior to submission of the first payment request, the Contractor shall submit to the County an Initial Construction Schedule – two hard copies and an electronic copy. The Initial Construction Schedule shall reflect the following information:

1. Procurement, submittals, construction drawings, shop drawings, approvals, fabrication and delivery of all major and long lead equipment and material items.
 2. Work expected to occur within the first 90 calendar days of the project, consistent with meeting all established milestone and completion dates.
 3. The Initial Schedule shall be descriptive of the work to be performed so that the Contractor and County can easily monitor progress of the Work. All work activities shall be cost loaded and will be the basis for payment during the beginning months of the project. All activities shall be coded to align with the approved Schedule of Values.
- C. Within 15 calendar days after receipt of the Initial Construction Schedule, the County will notify the Contractor of the acceptance or non-acceptance of the Initial Construction Schedule. In the event of disapproval, the Contractor shall resubmit the schedule within seven calendar days. No progress payments will be made for work in progress or completed until the Initial Construction Schedule is accepted.

1.5 CONSTRUCTION SCHEDULE

- A. The CPM Schedule to be prepared by the Contractor pursuant to this section will be a part of a total system for scheduling, reporting work progress, and preparing the monthly payment application.
1. Within 30 calendar days after the Notice to Proceed, the Contractor shall submit to the County the complete project schedule. In the event the complete project schedule is disapproved, the Contractor shall resubmit a corrected schedule within 15 calendar days after the notice of disapproval is received by the Contractor.
 2. Should the Contract Schedule not be accepted within 90 calendar days after Notice to Proceed, the Contractor may be due provisional progress payments(s) on work performed, based on the Initial Construction Schedule. It is the responsibility of the Contractor to reconcile such cost information and payments with the Contract Schedule. However, no payment shall be approved after the 90 calendar day period, until the Contract Schedule has been accepted by the County.
 3. All activities in the Official Contract Schedule shall have sufficient code structure to enable a sort by activity code, or "rollup" of the activities in the form of a Summary Schedule. The code structure will allow sufficient sorting capabilities to group by: responsibility (by subcontractor), location (building, floor, area, etc.), type (submittal, approval, change, etc), milestones, CSI division, etc.
 4. The approved Initial Construction Schedule shall be incorporated into the final Contract Schedule and shall represent the initial 90 calendar days of the Contract Schedule.
 5. The Schedule shall be a cost, and manpower resource-loaded CPM schedule. Mobilization (not to exceed 1/2 of 1 percent), bond, insurance and demobilization (equivalent to the mobilization amount) costs shall be shown separately; however, other general requirement costs, overhead, profit, etc., shall be prorated throughout all the activities. The cost-loaded activities of the Initial Contract Schedule shall be from the Schedule of Values line items and shall be the basis for establishing the distribution of costs within the Schedule of Values. Costs relating to each activity shall be distributed evenly over the duration of the activity.
 6. The initial submittal of the Contract Schedule shall not reflect contract changes or delays. These changes shall be added within the first Schedule Revision.
 7. The Contract Schedule shall include, in addition to construction activities, the following:
 - a. The submittal and approval of construction drawings, shop drawings and materials, the procurement, fabrication, delivery, and testing of major materials and equipment, and their installation and testing.
 - b. Include activities/task items for "Pre-Installation Meetings" as required by the Specs to precede work.

- c. Contract requirement dates of all or parts of the Work will be shown including all activities of the County that affect the progress of the Work.
 - d. Activities of completed work ready for use by next trade, etc.
 - e. Activities relating to different areas of responsibility, such as sub-contracted work which is distinctly separate from that being done by Contractor directly.
 - f. Different categories of work as distinguished by craft or crew requirements.
 - g. Different categories of work as distinguished by materials.
 - h. Distinct and identifiable subdivisions of work such as structural excavation, structural slabs, masonry walls, beams, columns, etc.
 - i. Location of work within the project that necessitates different times or crew to perform.
 - j. Outage schedules of limiting times that existing utility services may be interrupted to construct the Project.
 - k. Items listed separately in Schedule of Values for payment purposes. All activities shall be coded to align with the approved Schedule of Values.
 - l. Acquisition and installation of equipment and materials supplied and/or installed by County or separate contractors.
 - m. Material stored on site.
8. Major Equipment/Materials: For all major equipment and materials fabricated or supplied for Project, Construction Schedule shall show a sequence of activities including:
- a. Preparation of shop drawings and sample submissions.
 - b. Time required to obtain special inspection certifications and additional permits or certifications that may be required for specific tasks and/or systems.
 - c. Review of shop drawings and samples.
 - d. Shop fabrication, delivery, and storage.
 - e. Erection or installation.
 - f. Test of equipment and materials.
 - g. Required dates of completion.
9. Early Completion: Include in Construction Schedule an early completion date for the Project that is no earlier than Project's required date of completion.
10. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.
11. Construction activities are to be delineated separately for off-site sewer, site development, earthwork, utilities, and like work.
12. The time-scaled logic diagrams shall clearly indicate any work that is planned to be accomplished on a work schedule other than eight hours per day and 40 hours per week.
13. The CPM schedule shall show the order in which the Contractor proposes to carry out the Work with logical links between time-scaled work activities, and calculations made using the CPM to determine the controlling operation(s). The Contractor is responsible for assuring that all activity sequences are logical and that each schedule shows a coordinated plan for complete performance of the Work.
14. The basic concept of CPM time-scaled logic diagramming will be followed to show how the start of a given activity is dependent on the completion of preceding activities and its completion restricts the start of following activities. The diagrams shall show a continuous flow from left to right with no right to left sequences. The CPM schedule shall be based on early start and early finish dates

- of activities, and clearly show the primary paths of criticality using time scaled logic graphical presentation.
15. The number of activities shall be sufficient to assure adequate planning of the project, to permit monitoring and evaluation of progress, and to do an analysis of time impacts. Schedule activities shall include the following:
 - a. A clear and legible description.
 - b. Start and finish dates
 - c. A duration of not less than one working day, except for event activities, nor more than 15 working days in duration, except for passive activities such as concrete curing, or as otherwise authorized by the Project Manager, for any operation. All Humboldt County recognized holidays and non-working days shall be identified by way of calendar designations.
 - d. At least one predecessor and one successor is required for each activity, except for the project start and finish milestones.
 - e. All required constraints.
 - f. Codes for responsibility, stage, work shifts, location, and contract pay items.
 16. All activities shall be linked by realistic logical relationships only. Other type of relationships shall be permitted but shall be minimized (including, but not limited to: start-to-start, finish-to-finish, and start-to-finish relationships).
 17. The Schedule shall include the entire scope of work and show how the Contractor plans to complete the Work. The schedule shall show the activities that define the critical path. Multiple critical paths will not be accepted. A total of no more than 25 percent of the baseline schedule activities shall be critical or near critical, unless otherwise authorized by the County. Near critical is defined as float less than 10 days.
 18. The Official Contract Schedule shall not extend beyond the number of calendar days specified in the Contract. The baseline schedule shall have a data date of the first working day of the contract and not include any completed work to date. The baseline schedule shall not attribute negative float or negative lag to any activity.
 19. The following information will be provided in a report for each network activity:
 - a. Data Date
 - b. Activity number and description.
 - c. Activity duration in work days.
 - d. Activity cost. The Contract Price shall be broken down with the appropriate values distributed to the network diagram activities, coded to align with the approved Schedule of Values.
 - e. Working activities and General Conditions activities shall be identified separately.
 - f. Activity predecessors and successors.
 - g. Activity codes
 - h. Activity logic ties.
 - i. Scheduled, or actual and remaining durations (work days) for each activity.
 - j. Earliest Start and Earliest Finish Dates (calendar).
 - k. Actual Start and Actual Finish Dates (calendar).
 - l. Latest Start and Latest Finish Dates (calendar).
 - m. Free Float and Total Float (work days)
 - n. Percentage of activity complete and remaining duration for incomplete activities.
 - o. Lags.

- p. Required Constraints.
- 20. In addition to the information above, identify the adverse weather days anticipated per each month. Meteorological data for the area shall be based on historical information. An "Adverse Weather Day" will be days exceeding the average number of days per month when precipitation exceeds 0.1 inches based on NOAA Data.
- 21. Schedule review by the County and its agents is limited to ensuring the logic of sequencing is reasonable and Contractor has demonstrated ability to meet contractual milestone and completion dates. Acceptance of schedule shall not be construed as direction from the County to Contractor on how to schedule the Work.
- 22. Subsequent to acceptance of the contract (baseline) schedule, the Contractor will provide four copies of the network diagrams, plus four copies of all supporting documents (Contract Price, Schedule of Values, breakdown, etc.), as well as electronic copies of the network diagrams and supporting documents. Monthly update data will be submitted in the same form and numbers. Size of network diagrams shall be on sheets 34-inch x 44-inch, and include a title block, timeline, and run date on each page, as approved by the County.
- 23. After Completion and Acceptance of the Official Contract Schedule, the Contractor will provide computer reports and weekly and monthly reports thereafter.
- 24. Adverse weather will not be considered as a reason for delay, unless the number of days per a specific month exceed the normal adverse weather days of that month.

1.6 UPDATE SCHEDULES

- A. The Contractor shall submit an Update Schedule – hard copy and electronic copy -- and meet with the County to review progress, before the first day of each month, beginning one month after the Baseline Schedule is accepted. The Contractor shall allow 1 week for the County to review the updated schedule and all supporting data, except that the review period shall not start until the previous month's required schedule is accepted.
 - 1. The Update Schedule shall have a data date of the end of the month or other date established by the County. The Update Schedule shall show the status of work actually completed to date and the Work yet to be performed as planned. Actual activity start dates, percentage complete, and finish dates shall be shown. Actual durations for work that has been completed shall be shown on the Update Schedules for when the work actually occurred, including submittal reviews and contractor re-submittal times.
 - 2. The Contractor may include modifications such as adding or deleting activities or changing activity constraints, durations, or logic that do not: (1) alter the critical path(s) or near critical path(s), or (2) extend the schedule completion date compared to that shown on the current accepted schedule. The Contractor shall provide a narrative in writing that states the reasons for any changes to the planned work. If any proposed changes in planned work will result in (1) or (2) herein, then Contractor shall submit a time impact analysis as described herein.
 - 3. Any request for an adjustment of the Contract Time for completion submitted by Contractor for changes or alleged delays shall be accompanied by a complete Time Impact Analysis, (TIA), which shall be submitted for review within 15 days after the initial request for time by Contractor, or the impacting incident, whichever comes first.
 - 4. Schedule Reports: Initial and subsequent Update Schedule Reports will contain the following minimum information for each activity and shall be produced at a minimum of once a month:
 - a. Data date
 - b. Activity Number and Description;
 - c. Predecessor and successor activity numbers and descriptions;
 - d. Activity Codes;
 - e. Scheduled, or actual and remaining durations for each activity;

- f. Earliest start and finish (calendar) dates;
 - g. Actual start and finish (calendar) dates;
 - h. Latest start and finish (calendar) dates;
 - i. Free and total float (work days)
 - j. Percentage of each activity completed and remaining duration for incomplete activities as of each report;
 - k. Remaining float/days behind schedule;
 - l. Responsibility for activity;
 - m. Current status of activity as compared to baseline schedule.
5. Cost Reports: Initial and subsequent update Cost Reports will include the following information for each activity, sorted by trade activity:
- a. Activity Number and Description;
 - b. Activities coded to approved Schedule of Values.
 - c. Percentage of value of Work in place against total value;
 - d. Total cost of each activity;
 - e. Value of Work in place since last report;
 - f. Value of Work in place to date;
 - g. Value of incomplete Work.
6. Narrative Reports: Monthly Narrative Reports shall contain the following information for each monthly update:
- a. Description of overall project status
 - b. Description of problem areas (referenced to pending change orders as appropriate)
 - c. Current and anticipated delays not resolved by approved change order, including:
 - 1) Cause of the delay
 - 2) Corrective action and schedule adjustments to correct the delay
 - 3) Known or potential impact of the delay on other activities and milestones.
 - 4) Changes in the construction sequence
 - d. Pending items and status thereof, including but not limited to:
 - 1) Pending Change Orders
 - 2) Time Extension Requests
 - 3) Other Issues relating to Contract Time
 - e. Contract Completion Date status:
 - 1) If ahead of schedule, the number of calendar days ahead
 - 2) If behind schedule, the number of calendar days behind.
7. Three-Week Window: Weekly, for the progress meeting, the Contractor shall produce a three-week window of the current schedule, indicating activities scheduled for the current and following two week period.
8. Payment Progress Reporting: County and Contractor shall select a specified time for updating the Project Schedule at the jobsite each month.
- a. The County and Contractor and his/her designated scheduling representatives will attend the meeting to review the project progress.

- b. The schedule shall be the basis for monthly pay requests derived from the joint review of the cost loaded schedule.
 - c. All progress and status information provided by the Contractor shall clearly define the reporting period for which the status is provided.
9. At the monthly progress review meeting, the Contractor will provide "actual start" and "actual completion" dates for activities that were started or completed during the reporting period. The Contractor and the Project Manager will agree upon and assign percent complete values to activities in progress. In the event of a disagreement, the Project Manager shall make the final decision as to percent completion of each activity.
10. After joint review, the County will process the Contractor's pay request based on progress from the schedule.
 - a. Payment to the Contractor shall be made from the progress reflected by the Interim or the Contract Schedule.
11. Time is of the essence: Whenever it becomes apparent from the current monthly progress review that phases of Work or the Contract Completion Date will not be met, through no fault of the County, the Contractor will take the following actions with no change in the contract amount:
 - a. Increase construction manpower to eliminate any adverse backlog of work.
 - b. Increase the number of working hours per shift, shifts per day, working days per week, the amount of construction equipment, or any combination of the foregoing to eliminate the adverse backlog of Work.
12. The Schedule as accepted by the County will be an integral part of the Contract, and will establish interim Contract Completion Dates or milestone dates for the various activities.
13. Delays of any non-critical Work shall not be the basis for an extension of Contract Time.
14. FLOAT TIME; Float is defined as the time that a non-critical Work activity can be delayed or extended without delaying the scheduled completion of milestones specified in this Section or the scheduled completion date of the Work, or both. Float time is not for the exclusive use or benefit of either County or Contractor. Neither Contractor nor County shall have an exclusive right to the use of float. Contractor is to document the effect on the updated Contract Schedule whenever float has been used. However, if float time associated with any chain of activities is expended but not exceeded by any actions attributable to the County, the Contractor will not be entitled to any extension of Contract time.
15. The contractor shall not sequester float through strategies; including extending activity duration estimates to consume available float, using preferential logic, using extensive or insufficient crew/resource loading, special lead/lag logic restraints or imposed dates. Use of float time disclosed or implied by the use of alternate float suppression techniques shall be shared to the benefit of both the County and Contractor.
16. Should any activity fall 14 calendar days or more behind the Contract Schedule accepted by the County, the County will have the right to order the Contractor to expedite completion of that activity using whatever means are appropriate and necessary, without additional compensation to the Contractor.
17. Should any activity fall 21 or more calendar days behind the Official Contract Schedule approved by the County, through no fault of the County, the County will have the right to perform the activity or have the activity performed by whatever method the County deems appropriate. All costs incurred by the County in connection with expediting such activity under this subsection shall be reimbursed promptly to the County by the Contractor.
18. It is expressly understood and agreed that the failure by the County to either order the Contractor to expedite an activity or to expedite the activity by other means, pursuant to the two preceding paragraphs, shall not be considered precedent setting with respect to any other activities which may fall behind the Official Contract Schedule approved by the County; nor will it relieve the

Contractor from completion of the Work in accordance with the Official Contract Schedule and the Contract Completion Date.

19. County's acceptance of, or its review of, comments about any schedule or scheduling data shall not relieve the Contractor from its sole responsibility to plan for, perform, and complete the Work within the Contract Time. Acceptance of or review of comments about any schedule shall not transfer responsibility for any schedule to County nor imply their agreement with (1) any assumption upon which such schedule is based, or (2) any matter underlying or contained in such schedule.
20. Failure of County to discover errors or omissions in schedules that it has reviewed, or to inform Contractor that Contractor, Subcontractors, or others are behind schedule, or to direct or enforce procedures for complying with the Contract Schedule shall not relieve Contractor from its sole responsibility to perform and complete the Work within the Contract Time and shall not be a cause for an adjustment of the Contract Time or the Contract Sum.

B. Schedule Revisions

1. General: Revisions to accepted Construction Schedule must be approved in writing by the County and Contractor.
2. Contractor: Submit requests for revision to schedule to the County together with a Time Impact Analysis (TIA) and a written rationale for revisions and description of logic for re-sequencing work and maintaining Specific Contractual Milestone Dates listed in Contract Documents.
3. Proposed revisions acceptable to County may then be incorporated into next update of Construction Schedule following the review and acceptance.
4. Acceptance: Acceptance of revised schedule by County does not relieve Contractor of meeting contractual milestone and completion dates.

C. Time Impact Analysis (TIA):

1. The Contractor shall submit a written time impact analysis (TIA) – hard copy and electronic -- to the Project Manager with each request for adjustment of contract time, or when the Contractor or Project Manager consider that an approved or anticipated change may impact the critical path or contract progress.
2. The TIA shall illustrate the impacts of each change or delay on the current schedule completion date or internal milestone, as appropriate. The analysis shall use the accepted schedule that has a data date closest to and prior to the event. If the Project Manager determines that the accepted schedule used does not appropriately represent the conditions prior to the event, the accepted schedule shall be updated to the day before the event being analyzed. The TIA shall include an impact schedule developed from incorporating the event into the accepted schedule by adding or deleting activities, or by changing durations or logic of existing activities. If the impact schedule shows that incorporating the event modifies the critical path and scheduled completion date of the Official Contract Schedule, the difference between scheduled completion dates of the two schedules shall be equal to the adjustment of contract time. The Project Manager may construct and utilize an appropriate project schedule or other recognized method to determine adjustments in contract time until the Contractor provides the TIA.
3. The Contractor shall submit a TIA in duplicate within seven calendar days of receiving a written request for a TIA from the County. The Contractor shall allow the County 14 calendar days after receipt to accept or reject the submitted TIA. All approved TIA schedule changes shall be shown on the next update schedule.
4. If a TIA submitted by the Contractor is rejected by the County, the Contractor shall meet with the County to discuss and resolve issues related to the TIA. If agreement is not reached, the Contractor will be allowed 20 calendar days from the meeting to give notice of potential claim, as noted in Section 00700-7.4.A of the General Conditions. The Contractor shall only show actual as-built work, not unapproved changes related to the TIA, in subsequent update schedules. If

agreement is reached at a later date, approved TIA schedule changes shall be shown on the next updated schedule. The County will withhold remaining payment on the schedule contract item if a TIA is requested by the County and not submitted by the Contractor within 21 calendar days. The schedule item payment will resume on the next payment application after the requested TIA is submitted. No other contract payment will be retained regarding TIA submittals.

1.7 RECOVERY SCHEDULE

- A. General: Should updated Construction Schedule show Contractor to be 15 or more calendar days behind schedule at any time during construction, Contractor will prepare Recovery Schedule displayed on CPM schedule, at no additional costs to County. Prepare Recovery Schedule to show plan for returning to original schedule as expeditiously as possible, and in a manner that complies with paragraph 1.7 Update Schedules, requirements.
- B. Schedule Preparation: Within three calendar days after notice from the County, prepare and submit to the County a Recovery Schedule, incorporating best available information from Subcontractors and others which will permit return to Construction Schedule at earliest possible time. Prepare Recovery Schedule to same level of detail as Construction Schedule and for maximum duration of one month.
- C. Schedule Review: Within seven calendar days after notice from County, participate in conference with County to review and evaluate Recovery Schedule. Submit revisions necessitated by review for County's acceptance within four calendar days of conference. Use accepted Recovery Schedule for its planned duration as basis for return to Construction Schedule.
- D. Schedule Assessment: Seven days prior to expiration of Recovery Schedule, confer with the County to assess effectiveness of Recovery Schedule. As a result of this conference, the County will direct Contractor as follows:
 - 1. Behind Schedule: If the County determines Contractor is still behind schedule, the County will direct Contractor to prepare another Recovery Schedule for subsequent pay period.
 - 2. On Schedule: If County determines Contractor has successfully complied with provisions of Recovery Schedule, the County will direct Contractor to return to use of Construction Schedule.

1.8 FINAL UPDATE SCHEDULE

- A. The Contractor shall submit a final as-built schedule with actual start and finish dates for the activities, within 30 calendar days after completion of the contract work. The Contractor shall provide a written statement with this submittal signed by the Contractor's Project Manager and an officer of the company stating, "To my knowledge and belief, the enclosed final update schedule reflects the actual start and finish dates of the actual activities for the project contained herein." An officer of the company may delegate in writing the authority to sign the statement to a responsible manager.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Shop drawings.
 - 2. Product data.
 - 3. Samples
 - 4. Manufacturers' certificates.
 - 5. Deferred Agency Approvals.

1.2 DESCRIPTION

- A. Types of SUBMITTALS: Submittal procedures specified in this section include construction progress schedules, shop drawings, product data, samples, and manufacturer's installation instructions.
- B. Intent: Architect's review of shop drawings is intended to be a preview of what the Contractor intends to provide, and will function as an effort to foresee unacceptable materials or assemblies and to avoid the possibility of their rejection at the Project Site. Architect will review submittals only for conformance with the design concept of the Project and with the information given in the Contract Documents.
- C. The Architect's review of shop drawings will be general and shall not be construed:
 - 1. As permitting departure from the Contract requirements except as otherwise provided for under "substitution" provisions of Section 01 60 00;
 - 2. As relieving Contractor of responsibility for omissions or errors, including details, dimensions, materials, etc.;
 - 3. That review of a separate item indicates acceptance of an assembly in which the item functions. Architect will only review acceptance of an assembly in which the item functions. Architect will only review submittals required by Contract Documents for conformance with design concept of the Project and with the information given in the Contract Documents.

1.3 GENERAL SUBMITTAL PROCEDURES

- A. Submittals shall be classified as either electronic or physical. Procedures for each type of submittal, as described below, shall be followed.
- B. Transmit each submittal with "Submittal Transmittal" form supplied by County.
- C. Number each submittal sequentially with a decimal for resubmittals. Also include in the submittal number the specification section number as a suffix (ie. 2.01-07 81 16).
- D. Identify Project, Contractor, Subcontractor or supplier; pertinent Drawing sheet and detail number(s), and specification Section number, as appropriate.
- E. Apply Contractor's stamp and signature or initial (electronically or physically) certifying that review, verification of Products required, field dimensions, adjacent construction Work, and coordination of information, is in accordance with the requirements of the Work and Contract Documents.

- F. Unless otherwise authorized by the Architect, all of the submittals required by a specification section shall be submitted together at the same time. Electronic submittals of product data, shop drawings, etc. may be submitted ahead of physical color samples with approval of the Engineer. Submittals that do not include all required submittals for a given specification section will be returned without review.
- G. Schedule submittals to expedite the Project, and deliver to Owner's Representative. Coordinate submission of related items.
- H. Identify variations from Contract Documents and Product or system limitations that may be detrimental to successful performance of the completed Work.
- I. Substitutions must be submitted according to Section 01 60 00. Substitutions submitted without following this procedure will be rejected.
- J. Provide space for Contractor and Architect review stamps.
- K. Revise and resubmit submittals as required, identify all changes made since previous submittal.
- L. Distribute copies of reviewed submittals to concerned parties. Instruct parties to promptly report any inability to comply with provisions.

1.4 ELECTRONIC SUBMITTAL PROCEDURES

- A. Construction Progress Schedules, Product Data, Shop Drawings, and Manufacture's Installation Instructions shall be submitted electronically.
- B. Electronic submittals shall be emailed or uploaded to Owner's Representative in full size PDF format. Do not reduce Shop Drawings from original sheet size.
- C. PDF copy of electronic submittals will be returned to the Contractor. Contractor may distribute submittals to the concerned parties electronically or physically. Any printing costs for physical distribution of submittals shall be borne by the Contractor. The Architect will not print copies for distribution.
- D. Follow all General Submittal Procedures as described above.

1.5 PHYSICAL SUBMITTAL PROCEDURES

- A. Samples, Color Charts, and Agency Deferred Approvals shall be physical submittals. Construction Progress Schedules, Product Data, Shop Drawings and Manufacturer's Installation Instructions may, with the County's approval, be physical submittals.
- B. The County will retain a minimum of three samples, submit the number that will be needed by contractor plus three.
- C. Follow all General Submittal Procedures as described above.

1.6 CONTRACTOR RESPONSIBILITIES

- A. Review shop drawings, product data and samples prior to submission.
- B. Determine and verify:
 - 1. Field measurements.
 - 2. Field construction criteria.
 - 3. Catalog numbers and similar data.
 - 4. Conformance with specifications.
 - 5. Conformance with applicable codes.

- C. Submittals giving inadequate indication of contractor review and approval will be returned without review, for resubmission.
- D. Coordinate each submittal with requirements of the Work and of the Contract Documents.
- E. Notify the Architect in writing, at time of submission, of any deviations in the submittals from requirements of the Contract Documents.
- F. Begin no fabrication or construction activity that requires submittals until return of submittals with Architect's stamp and initials or signature indicating finish review.
- G. After Architect's final review, distribute copies.

1.7 SHOP DRAWINGS

- A. Submit electronically.
- B. After review and distribution in accordance with Submittal Procedures, retain one copy of all reviewed shop drawings at the job and label them "PROJECT RECORD" as described in Section 01 77 00 Closeout Procedures.

1.8 PRODUCT DATA

- A. Submit electronically.
- B. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information unique to this Project.
- C. After review, distribute in accordance with Submittal Procedures and provide copies for Record Documents as described in Section 01 77 00.
- D. Show dimensions and clearances required.

1.9 SAMPLES

- A. Submit samples to illustrate functional and aesthetic characteristics of the Product, with integral parts and attachment devices. Provide units identical with final condition of proposed materials or products for the work. Coordinate sample submittals for interfacing work.
- B. Submit samples of finishes from the full range of manufacturers' standard colors textures, and patterns for Architect's selection.
- C. Include identification on each sample, with full Project information.
- D. Submit the number or samples specified in individual specification Sections; three of which will be retained by Engineer.
- E. Reviewed samples which may be used in the Work are indicated in individual specification Sections.

1.10 MANUFACTURER'S INSTRUCTIONS

- A. Submit manufacturers' instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing, electronically.
- B. Identify conflicts between manufacturers' instructions and Contract Documents.

1.11 MANUFACTURER'S CERTIFICATES

- A. When specified in individual specification Sections, submit manufacturers' certificate electronically.
- B. Contractor/Subcontractor Warranty form for the work of the particular spec section, completed except for signature. The Effective Date of warranty shall reference the date to be established as Final Acceptance.

1.12 DEFERRED AGENCY APPROVALS

- A. The General Contractor shall submit, or cause to be submitted by Subcontractors, within 60 days of contract signing, all required deferred approvals. The General Contractor or Subcontractors shall complete all deferred approval packages, including design and engineering calculations, in a manner acceptable to the agency requiring such submittal. The General Contractor shall within 15 days of contract signing, develop a schedule of critical dates of deferred approval acceptance by the reviewing agency. These critical dates shall be reflected in the required project schedule and all deferred approvals submitted within 45 days of schedule submittal.
- B. For all deferred items, it is the responsibility of the contractor to see that all submittals are stamped and signed by a California licensed design professional (an architect or PE is acceptable). The County and Architect will then review the submittal and if the design is acceptable provide a Statement of General Conformance that the submittal conforms to the design intent. Neither the Project's Architect or any of its consulting engineers will stamp and sign these deferred approval submittals other than with the standard shop drawing stamp. It is the responsibility of the manufacturing entity to procure necessary stamps and signatures from its own design professionals.
- C. All Deferred Approvals shall be submitted by the County to all required permitting agencies. If the Contractor fails to provide a required submittal, the Owner may elect to engage the design team or additional consultants to produce these and back charge the General Contractor for the cost and any schedule impact this may cause.

1.13 ACTION ON SUBMITTALS

- A. The County will review each submittal, mark with a "Review Code" and where possible, return within a reasonable period of time from date of receipt. Where submittal must be held for coordination, Contractor will be so advised without delay. Action markings shall be interpreted as follows:
 - 1. No Exceptions Noted
 - 2. Implement Exceptions Noted
 - 3. Revise and Resubmit
 - 4. Rejected
 - 5. Cancelled

PART 2 PRODUCTS (NOT USED)

PART 2 - PART 3 EXECUTION (NOT USED)

END OF SECTION

PART 1 GENERAL

1.1 SUMMARY

- A. This Section specifies administrative and procedural requirements for handling and processing the following contract modifications:
 - 1. Request for Information (RFI).
 - 2. Field Order (FO).
 - 3. Request for Cost Proposal (RFCP).
 - 4. Cost Proposal (CP).
 - 5. Change Orders (CO).

1.2 DEFINITIONS

- A. Request for Information (RFI)
 - 1. Written request submitted by Contractor to Owner's Representative via the County's online project management system on a form supplied by Owner's Representative requesting clarification, interpretation, or additional information pertaining to Contract Documents.
 - 2. An RFI shall not be used as a vehicle for only confirming or verifying issues.
- B. Field Order (FO)
 - 1. Owner's Representative written directives to the Contractor covering a specific aspect of work, signed by the Owner or Owner's lead agency that authorizes changes in the Work to expedite the change order process.
- C. Request for Cost Proposal (RFCP)
 - 1. Written request by the Owner's Representative to the Contractor to quote change to Contract Sum and/or Contract Time for proposed change to Contract Document.
- D. Cost Proposal (CP)
 - 1. Written request by the Contractor to the Owner's Representative to change Contract Sum and/or Contract Time for proposed change to Contract Document.
- E. Change Order (CO)
 - 1. Initiated by the Owner, Contractor, Consultant, Owner's lead agency, or the Owner's Representative and signed by the Owner and Contractor stating their agreement to a change to Contract Documents and adjustment to Sum and/or Contract Time.

1.3 REQUEST FOR INFORMATION (RFI)

- A. Submit RFIs numbered in sequential order, reviewed by the Contractor with respect to Contract Documents.
 - 1. Submit RFI's on forms designated by the Owner's Representative.
- B. Owner's Representative will monitor the RFI process and responses from the Consultant. The Consultant will receive RFI's only from the Owner's Representative; Consultant will not accept RFI's directly from any other entity.
- C. Owner's Representative will receive only legible, properly prepared RFI:
 - 1. Unreadable facsimile machine RFI's, illegibly written RFI's, or RFI's with incomplete information, will be returned promptly without action.
 - 2. RFI's may be transmitted to Owner's Representative by online project management system.

- a. Owner's Representative will forward to Consultant for review, and return response by same method received from Contractor.
- 3. Consultant will review RFI's with respect to Contract Documents and return response in a timely manner, generally within 7 calendar days, or commensurate with RFI subject.
 - a. RFI's marked "URGENT" will take precedence over outstanding RFI's and be answered by Consultant as soon as possible.
- D. Contractor being fully familiar with Contract Documents, shall not be relieved of responsibility to coordinate the Work to prevent adverse impact to Project schedule when submitting RFIs to Owner's Representative for clarification or interpretation of Contract Documents, or additional information.
- E. If the Contractor believes the scope of work referenced in the RFI has a cost and /or time impact, he will not proceed with the work until either a Field Order or a Change Order has been issued.

1.4 FIELD ORDER (FO)

- A. Field Orders may include supplementary or revised Drawings and/or Specification to describe changes to Contract Documents.
- B. Field Orders will be executed on forms designated by the Owner's Representative.
- C. Field Orders may be generated by the Contractor's written notice submitted on a Cost Proposal form, that an RFI response or other unforeseen condition has changed the Contract cost and /or time, and that schedule impact will result if written directive is not provided in a timely manner.
- D. Contractor shall provide an estimate of cost and/or time impact at the time of the request for a Field Order.
- E. Owner's Representative will review the request for a Field Order and initiate a written Field Order for authorization by the Owner or Owner's lead agency.
- F. If the Field Order is approved by the Owner or Owner's lead agency, Owner's Representative will release the signed Field Order to the Contractor. If rejected, the Contractor is so notified by the Owner's Representative.

1.5 REQUEST FOR COST PROPOSAL (RFCP)

- A. Request for Cost Proposal is an informational request only, and is not an instruction or authorization to execute a change, or an order to stop Work in progress.
- B. Request for Cost Proposal may include supplementary or revised Drawings and/or Specification to describe proposed changes to Contract Documents.
- C. Contractor shall submit cost and/or time quotation to Owner's Representative within 15 calendar days following receipt of Request for Cost Proposal.

1.6 COST PROPOSAL (CP)

- A. Contractor shall submit to the Owner's Representative a Cost Proposal for all occurrences the Contractor believes impacts Scope of Work cost and/or time.
 - 1. A Cost Proposal shall be submitted within 15 calendar days of the occurrences.

- B. Submit Cost Proposal numbered in sequential order, reviewed by the Contractor with respect to Contract Documents.
 - 1. Submit Cost Proposals on forms designated by the Owner's Representative.
- C. All Cost Proposals submitted shall have detailed breakdown for all associated work, cost and/or time.
- D. Owner's Representative will solicit and monitor independent cost estimates responses from the Consultant.
- E. Owner's Representative shall return Cost Proposal responses and reviews to the Contractor within 15 calendar days following receipt of Cost Proposal.
- F. A processed Cost Proposals is informational back-up for a potential Change Order, and not an instruction or authorization to execute a change, or an order to stop Work in progress.

1.7 CHANGE ORDER (CO)

- A. Change Orders may be initiated by the Owner, Contractor, Consultant, Owner's lead agency, or the Owner's Representative.
- B. Changes to the Project Contract Sum and/or Contract Time listed or indicated in Change Orders shall include or be determined by methods described in the General Conditions.
- C. Owner's Representative has responsibility for processing and administering Change Orders for the Project, and will prepare each Change Order using form designated by the Owner's Representative.
- D. Contractor shall provide all final Cost Proposals for a Change Order. The Consultant shall provide independent cost estimates to Cost Proposals.
 - 1. The Owner's Representative may request that the contractor revise each cost proposal if there is a differential between the Contractor's proposal and the Consultant's cost estimate.
 - 2. If no agreement is reached, the Owner's Representative may issue a time and material Field Order.
 - a. Use Daily Force Account Report designated by Owner's Representative.
- E. The Contractor, Consultant, Owner's Representative, Owner's lead agency and Owner will sign a fully documented Change Order.

1.8 CORRELATING CHANGE ORDERS WITH OTHER CONTRACT REQUIREMENTS

- A. Revise Schedule of Values and Applications for Payment to record each Change Order as a separate item of work with adjustment to Contract Sum and Contract Time.
- B. Revise Construction Schedule to reflect each change in Contract Time.
- C. Record modifications in Record Documents.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Qualifications.
- B. Quality Assurance
- C. Tolerances.
- D. Labeling.
- E. Seismic Considerations.
- F. Conflicting Requirements
- G. Field samples.
- H. Testing and inspection laboratory services.
- I. Manufacturers' field services and reports.

1.2 QUALIFICATIONS

- A. General: Qualifications paragraphs in this Subsection establish the minimum qualification levels required; individual Specification Sections specify additional requirements.
- B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- D. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product, that are similar to those indicated for this Project in material, design, and extent.
- E. Specialists: Certain sections of the Specifications require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.

1.3 QUALITY ASSURANCE

- A. Monitor quality control over suppliers, manufacturers, products, services, site conditions and workmanship, to produce Work of specified quality.
- B. Comply fully with manufacturers' instructions, including each step in sequence.

- C. When manufacturers' instructions conflict with the Contract Documents, request clarification from Engineer before proceeding.
- D. Comply with specified standards as a minimum quality for the Work except when more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.
- E. Work shall be performed by persons qualified to produce workmanship of specified quality.
- F. Verify field measurements are as indicated on Shop Drawings or as instructed by manufacturer.
- G. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion or disfigurement.
- H. Contractor's Line of Authority: Contractor shall provide one person who shall be both knowledgeable and responsible for all work to be performed on this project at all times during normal work hours. In Contractor's absence, Contractor's appointed representative shall be responsible for all directions given him and said directions shall be binding as if given to Contractor. Contractor's representative shall be responsible to coordinate all work to be performed.
- I. Shop and field work shall be performed by mechanics skilled and experienced in the fabrication and installation of the work involved. All work on this project shall be done in accordance with the best practices of the various trades involved and in accordance with Drawings, accepted shop drawings, and Specifications.
- J. All work shall be erected and installed plumb, level, square and true and in proper alignment and relationship to the work of other trades. All finished work shall be free from defects. Engineer and/or Architect reserve the right to reject any materials and workmanship that are not considered to be up to the highest standards of the various trades involved. Such inferior material or workmanship shall be replaced at no cost to County.
- K. All work shall be installed by knowledgeable installers and defined "Eligible" by the specified materials manufacturers. Specifications and recommendations of the manufacturer, whose materials are used, shall be strictly adhered to during application or installation of materials.
- L. Any additional work beyond that specified or illustrated, or any modification thereto, that is necessary for the furnishing of warranty shall be provided by Contractor at no cost to County.

1.4 TOLERANCES

- A. Monitor fabrication and installation tolerance control of products to produce acceptable Work. Do not permit tolerances to accumulate.
- B. Comply with manufacturers' tolerances. When manufacturers' tolerances conflict with Contract Documents, request clarification from Engineer before proceeding.
- C. Adjust products to appropriate dimensions; position before securing products in place.

1.5 LABELING

- A. Attach label from agency approved by authority having jurisdiction for products, assemblies, and systems required to be labeled by CBC.

- B. Label Information: Include manufacturer's or fabricator's identification, approved agency identification, and the following information, as applicable, on each label.
 - 1. Model number.
 - 2. Serial number.
 - 3. Performance characteristics.

1.6 SEISMIC CERTIFICATION OF NONSTRUCTURAL COMPONENTS

- A. The manufacturer of each designated seismic system components subject to the provisions of ASCE 7 Section 13.2.2 shall test or analyze the component and its mounting system or anchorage and submit a certificate of compliance for review and acceptance by the registered design professional responsible for the design of the designated seismic system and for approval by the building official in accordance with 2019 CBC, Chapter 17 "Structural Tests and Special Inspections", Section 1708 "In Situ Load Tests".

1.7 CONFLICTING REQUIREMENTS

- A. General: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer uncertainties and requirements that are different, but apparently equal, to Engineer for a decision before proceeding.
- B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Engineer for a decision before proceeding.

1.8 FIELD SAMPLES

- A. Install field samples at the site as required by individual specifications Sections for review.
- B. Acceptable samples represent a quality level for the Work.
- C. Where field sample is specified in individual Sections to be removed, clear area after field sample has been accepted by Architect.

1.9 INSPECTION AND TESTING LABORATORY SERVICES

- A. County will select and pay for the services of an independent Inspection/Testing Laboratory to perform inspections and testing.
 - 1. Special Inspector: As required by 2019 CBC including Chapter 17 "Structural Tests and Special Inspections."
 - a. Special Inspection: As defined in CBC Chapter 17, Section 1704 "Special Inspections and Tests, Contractor Responsibility and Structural Observation."
- B. Inspection/Testing Laboratory will perform inspections, tests, and other services specified in individual specification Sections and as required by Engineer.
 - 1. Testing Equipment: Calibrated at reasonable intervals with devices of an accuracy traceable to National Bureau of Standards or accepted values of natural physical constants.
- C. Reports will be submitted by inspection/Testing Laboratory to Architect, Engineer, and Contractor, indicating observations and results of tests and indicating compliance or non-

compliance with the Contract Documents.

- D. Cooperate with Inspection/Testing Laboratory; furnish samples of materials, design mix, equipment, tools, storage and assistance as requested.
 - 1. Notify Engineer, and Inspection/Testing Laboratory 24 hours prior to expected time for operations requiring services.
 - 2. Make arrangements with Inspection/Testing Laboratory and pay for additional samples and tests required for Contractor's use.
- E. The Inspection/Testing Laboratory shall perform inspection of work to determine conformance with these Standards.
 - 1. Request for inspection shall be made to the office of the Inspection/Testing Laboratory a minimum of 24 hours in advance of the time the inspection is desired.
 - 2. Underground work shall not be backfilled or covered until an inspection by the Inspection/Testing Laboratory has been completed and the work approved. Any work that is covered without inspection shall be uncovered at Contractor's expense, for completion of inspection work.
 - 3. The Inspection/Testing Laboratory shall have access to the Work at all times and shall be furnished every reasonable facility for ascertaining that the work done, materials used and workmanship performed are in accordance with the requirements of these Standards.
 - 4. Inspection of the Work shall not relieve Contractor of any of his obligations to satisfactorily perform the Work in accordance with requirements of Contract Documents.
- F. Retesting or reinspection required because of non-conformance to specified requirements shall be performed by the same Inspection/Testing Laboratory. Payment for retesting will be charged to Contractor by deducting inspection or testing charges from the Contract Sum.
- G. If the Work to be tested or inspected is not ready or sufficiently completed to allow the test/inspection service to complete required test(s)/inspection(s), costs and expenses of the test/inspection service to return to the Site or fabrication facility to perform/complete required test(s)/inspection(s) shall be charged to Contractor by deducting such costs and expenses from the Contract Sum.
- H. Contractor shall coordinate items to be tested to minimize the number of tests and trips to the site by the testing laboratory.
- I. All Samples, specimens and tests shall be prepared and accomplished by a properly qualified person or testing laboratory, selected by County, who shall furnish County, Architect, Engineer, and Contractor with test reports, including test results, and stating that they were prepared in accordance with the specified provisions. All tests as well as sampling and preparation of samples shall be in accordance with applicable ASTM and other specified standards.

1.10 MANUFACTURERS' FIELD SERVICES AND REPORTS

- A. When specified in individual specification Sections, material and product suppliers, and manufacturers shall provide qualified personnel to observe site conditions, conditions of surfaces and installation, quality of workmanship, start-up of equipment, testing, adjusting, and balancing of equipment, as applicable, and to initiate instructions when necessary.
- B. Submit qualifications of qualified personnel to Engineer at least thirty days in advance of required observations.
- C. Qualified personnel shall report observations, site decisions, and supplemental instructions

given to applicators and installers, and description of work installed contrary to manufacturers' written instructions, as applicable.

- D. Submit report in duplicate within thirty days of observation to Engineer for review.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify and ensure that existing site conditions and substrate surfaces are acceptable for subsequent Work. Beginning new Work means acceptance of existing conditions.
- B. Verify and ensure that existing substrate is capable of structural support and attachment of new Work being applied or attached.
- C. Examine and verify specific conditions described in individual specification Sections.
- D. Verify utility services are available, of correct characteristics, and in correct locations.

3.2 PREPARATION

- A. Clean substrate surfaces prior to applying next material or substance.
- B. Seal cracks or openings of substrate prior to applying next material or substance.
- C. Apply manufacturer required or recommended substrate primer, sealer, or conditioner prior to applying new material or substance in contact or bond.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Reference Standards.
- B. Definitions.
- C. Abbreviations and Acronyms.

1.2 REFERENCES

- A. General: References are made throughout the Specifications to various codes, reference standards, practices and requirements for materials, work quality, installation, inspections and tests which are published and issued by government agencies, professional and trade organizations, societies, associations and testing agencies. References to these publications are made by acronyms or abbreviations as listed in this Section.
- B. Obtain copies of reference standards, manuals and codes directly from publication sources as needed for proper performance and completion of the Work.
- C. Standards, manuals and codes referenced in the Specifications form part of these Specifications to the extent referenced. No provisions of any such standard, specification, manual, or code or instruction shall be effective to change the duties and responsibilities of County, Architect, or Contractor; any of their subcontractors, consultants, agents, or employees from those set forth in the Contract Documents; nor shall it be effective to assign to County, Architect or any of Architect's consultants, agents, or employees, a duty or authority to supervise or direct the furnishing or performance of the Work or any duty or authority to undertake responsibility inconsistent with the provisions of the Contract Documents.
- D. Reference to standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes as of the date of issue of this Project Manual unless noted otherwise.

1.3 DEFINITIONS

- A. General: Words and abbreviations used in the Specifications are given meaning as defined in "The American Heritage Dictionary of the English Language" and as commonly used and accepted in the construction industry. Abbreviations and symbols used on Drawings are identified on Drawings.
- B. Words and Terms: The following words and terms used in the Specifications shall mean as indicated.
 - 1. Accepted Comparable: Reviewed and accepted by the County as being comparable in quality, utility, and appearance.
 - 2. Approved: As accepted by the County.
 - 3. Words and terms "or Architect Approved Substitute" and "or Comparable" used in the Specifications shall have the same meaning as "Accepted Comparable".
 - 4. Contractor Shall: To be concise; sentences, statements, and clauses used in the Specifications exclude any form of the verb "shall", which is normally expressed in a verb phrase with verbs such as "furnish", "install", "provide", "perform", "construct", "erect", "comply", "apply", "submit", etc. Any such sentences, statements, and clauses are to be interpreted to include applicable form of phrase "Contractor shall".
 - 5. Furnish: Supply and deliver to Project site, ready for installation; unload and inspect for damage.

6. Install: Anchor, fasten, or connect in place and adjust for use; place or apply in proper position and location; establish in place for use or service including all necessary labor, tools, equipment, and implements necessary to perform work indicated, ready for operation or use.
7. Observe: Used in reference to Architect means to become familiar with the process and quality of the Work and to determine if the Work is proceeding in general accordance with the Contract Documents based on what is plainly visible at the construction site, without removal of its materials or other construction that is in place.
8. Products: New material, machinery, components, equipment, fixtures, and systems forming the Work, but does not include machinery and equipment used for preparation, fabrication, conveying and erection of the Work.
9. Provide: Furnish and install all items necessary to complete work, ready for operation or use.

1.4 CODES, REGULATIONS, GOVERNING AGENCIES

- A. California Code of Regulations.
 1. Title 8, Division 1, Chapter 3.2 – California Occupational Safety and Health Regulations (Cal/OSHA).
 2. Title 8, Division 1, Chapter 4, Subchapter 4 – Construction Safety Orders.
 3. Title 8, Division 1, Chapter 4, Subchapter 6 – Elevator Safety Orders
 4. Title 19, Division 1 – Regulations of the State Fire Marshal (SFM).
 5. Title 24 – California Building Standards Code (CBSC).
 - a. Part 1 – California Administrative Code (CAC).
 - b. Part 2 – California Building Code (CBC).
 - c. Part 3 – California Electrical Code (CEC).
 - d. Part 4 – California Mechanical Code (CMC).
 - e. Part 5 – California Plumbing Code (CPC).
 - f. Part 6 – California Energy Code (CEC).
 - g. Part 7 – California Elevator Safety Construction Code.
 - h. Part 8 – California Historical Building Code.
 - i. Part 9 – California Fire Code (CFC).
 - j. Part 10 – California Existing Building Code.
 - k. Part 11 – California Green Building Standards Code.
 - l. Part 12 – California Referenced Standards Code.
- B. California Department of Transportation (Caltrans).
- C. California Department of General Services (DGS).
- D. California Environmental Protection Agency (Cal/EPA).
 1. California Air Resources Board (CARB).
 2. California State Water Resources Control Board (SWRCB).
 3. Department of Pesticide Regulation (DPR).
- E. Code of Federal Regulations (CFR) Title 28, Part 36 – ADA Standards for Accessible Design, Appendix A – ADA Accessibility Guidelines (ADAAG) for Buildings and Facilities.
- F. Occupational Safety and Health Act (OSHA).
- G. U.S. Environmental Protection Agency (EPA).
- H. U.S. Department of Energy (DOE).

1.5 REFERENCES, ABBREVIATIONS, AND ACRONYMS

AA	Aluminum Association.
AAADM	American Association of Automatic Door Manufacturers.
AABC	Associated Air Balance Council.
AAC	Aluminum Anodizer's Council.
AAMA	American Architectural Manufacturers Association.
AASHTO	American Association of State Highway and Transportation Officials.
AATCC	American Association of Textile Chemists and Colorists.
ABMA	American Boiler Manufacturer's Association.
ACGIH	American Conference of Government Industrial Hygienists, Inc.
ACI	American Concrete Institute.
ACPA	American Concrete Pipe Association.
AF&PA	American Forest and Paper Association (formerly National Forest Products Association).
AFBMA	Anti-Friction Bearing Manufacturer's Association.
AGA	American Gas Association.
AGC	Associated General Contractors of America.
AGMA	American Gear Manufacturers Association
AHA	American Hardboard Association.
AHJ	Authority Having Jurisdiction.
AI	Asphalt Institute.
AIA	American Institute of Architects.
AIEE	American Institute of Electrical Engineers.
AIHA	American Industrial Hygiene Association.
AISC	American Institute of Steel Construction.
AISI	American Iron and Steel Institute.
AITC	American Institute of Timber Construction.
ALSC	American Lumber Standards Committee.
AMCA	Air Movement and Control Association.
ANSI	American National Standards Institute, Inc.
APA	The Engineered Wood Association.
API	American Petroleum Institute.
APWA	American Public Works Association.
AQMD	Air Quality Management District.
ARI	Air-Conditioning and Refrigeration Institute.
ARMA	Asphalt Roofing Manufacturers Association.
ASCE	American Society of Civil Engineers.
ASD	Advanced Simulation and Design.
ASHRAE	American Society of Heating Refrigerating and Air Conditioning Engineers.
ASME	American Society of Mechanical Engineers.
ASPA	American Sod Producers Association.
ASSE	American Society of Sanitary Engineers.
ASTM	American Society for Testing and Materials.
ATF	Academy of Textiles and Flooring.
AWC	American Wood Council.
AWCI	Association of Wall and Ceiling Industries.
AWG	American Wire Gage.
AWI	Architectural Woodwork Institute.

AWPA	American Wood Protection Association.
AWS	American Welding Society.
AWWA	American Water Works Association.
BAAQMD	Bay Area Air Quality Management District
BHMA	Builders Hardware Manufacturers Association.
BIA	Brick Industry Association.
BOCA	Building Officials and Code Administrators International, Inc.
CAN/ULC	Underwriters' Laboratory of Canada.
CAS	Chemical Abstracts Service (division of the American Chemical Society).
CBC	California Building Code
CBM	Certified Ballast Manufacturers.
CCR	California Code of Regulations
CDA	Copper Development Association.
CE	US Army Corps of Engineers
CFFA	Chemical Fabrics and Film Association, Inc.
CFR	Code of Federal Regulations
CISCA	Ceiling and Interior Systems Construction Association.
CISPI	Cast Iron Soil Pipe Institute.
CLFMI	Chain Link Fence Manufacturing Institute.
CMU	Concrete Masonry Unit
CPA	Composite Panel Association.
CRA	California Redwood Association.
CRI	Carpet and Rug Institute.
CRSI	Concrete Reinforcing Steel Institute.
CS	Commercial Standard.
CSA	Corrections Standards Authority
CSI	Construction Specifications Institute.
CSIAC	California State Industrial Accident Commission.
DHI	Door Hardware Institute.
EIA	Electronic Industries Association.
EIMA	EIFS Industry Manufacturers Association.
ETL	Electrical Testing Laboratories.
EWS	Engineered Wood Systems
FEMA	Federal Emergency Management Agency.
FM	Factory Mutual Research and Engineering Corporation.
FMRC	Factory Mutual Research Corporation.
FS	Federal Specification – U.S. General Services Administration.
FSC	Forest Stewardship Council.
GA	Gypsum Association.
GANA	Glass Association of North America.
GMA	Flat Glass Marketing Association.
HPVA	Hardwood Plywood and Veneer Association.
IAPMO	International Association of Plumbing and Mechanical Officials.
ICC	International Code Council, Inc.
ICC	Interstate Commerce Commission.
ICC-ES	ICC Evaluation Service, Inc.

ICEA	Insulated Cable Engineers Association.
ICRI	International Concrete Repair Institute
IEEE	Institute of Electrical and Electronics Engineers.
IESNA	Illuminating Engineering Society of North America
IMIAC	International Masonry Industry All-Weather Council.
IPCEA	Insulated Power Cable Engineers Association.
ISO	International Standards Organization.
ITS	Intertek Testing Services.
LEED™	Leadership in Energy and Environmental Design (USGBC standard).
LRFD	Load and Resistance Factor Design.
LSGA	Laminators Safety Glass Association.
MBMA	Metal Building Manufacturers Association.
MFMA	Maple Flooring Manufacturers Association.
MFMA	Metal Framing Manufacturers Association.
MIA	Marble Institute of America
MIL	Military Specifications (U.S. Department of Defense).
ML/SFA	Metal Lath/Steel Framing Association Division of NAAMM.
MPI	Master Painters Institute.
MS4	Municipal Separate Storm Sewer Systems.
MSDS	Material Safety and Data Sheet.
MSJC	Masonry Standards Joint Committee.
MSMA	Metal Stud Manufacturers Association.
MSS	Manufacturers Standardization Society of the Valve and Fittings Industry.
MUTCD	Manual of Uniform Traffic Control Devices (U.S. Department of Transportation).
NAAMM	National Association of Architectural Metal Manufacturers.
NAFS	North American Fenestration Standard (Co-published by AAMA & WDMA).
NAPHCC	National Association of Plumbing Heating Cooling Contractors.
NBBPVI	National Board of Boiler and Pressure Vessel Inspectors.
NBFU	National Board of Fire Underwriters.
NBGQA	National Building Granite Quarries Association, Inc.
NCMA	National Concrete Masonry Association.
NCPWB	National Certified Pipe Welding Bureau.
NCRP	National Council on Radiation Protection and Measurement.
NEBB	National Environmental Balancing Bureau.
NEC	National Electrical Code.
NEHRP	National Earthquake Hazards Reduction Program.
NEMA	National Electrical Manufacturers Association.
NES	National Evaluation Service, Inc.
NFPA	National Fire Protection Association.
NFRC	National Fenestration Rating Council.
NIBS	National Institute of Building Sciences.
NIST	National Institute of Science and Technology.
NOFMA	National Oak Flooring Manufacturers Association.
NPDES	National Pollutant Discharge Elimination System.
NRCA	National Roofing Contractors Association.
NRMCA	National Ready Mixed Concrete Association.

NSF	National Sanitation Foundation.
NTMA	National Terrazzo and Mosaic Association.
NWWDA	National Wood Window and Door Association.
OSHA	Occupational Safety and Health Act of 1970.
PCA	Portland Cement Association.
PCI	Precast Prestressed Concrete Institute.
PDI	Plumbing and Drainage Institute.
PEI	Porcelain Enamel Institute.
PS	Voluntary Product Standard (US Department of Commerce / NIST).
RCSC	Research Council on Structural Connections.
RIS	Redwood Inspection Service.
RMA	Rubber Manufacturers Association.
SC	Shading Coefficient.
SCAQMD	South Coast Air Quality Management District
SDI	Steel Deck Institute.
SDI	Steel Door Institute.
SF	Square Feet
SFBC	South Florida Building Code.
SHGC	Solar Heat Gain Coefficient.
SIGMA	Sealed Insulating Glass Manufacturers Association.
SMACNA	Sheet Metal and Air Conditioning Contractors National Association.
SPRI	Single-Ply Roofing Institute.
SSMA	Steel Stud Manufacturers Association.
SSPC	The Society for Protective Coatings.
SWI	Steel Window Institute.
SWPPP	Storm Water Pollution Prevention Plan.
SWRI	Sealant, Waterproofing, and Restoration Institute.
TCA	Tile Council of America.
TEMA	Tubular Exchanger Manufacturers Association, Inc.
TMS	The Masonry Society.
TPI	Truss Plate Institute.
TRI	Tile Roofing Institute.
UL	Underwriters Laboratories, Inc.
ULC	Underwriters Laboratories of Canada.
USGBC	US Green Building Council.
VOC	Volatile Organic Compounds.
WCLIB	West Coast Lumber Inspection Bureau.
WDMA	Window and Door Manufacturers Association (formerly NWWDA - National Wood Window and Door Association).
WDMA	Window and Door Manufacturers Association.
WH	Warnock Hersey.
WI	Woodwork Institute (formerly WIC – Woodwork Institute of California).
WSRCA	Western States Roofing Contractors Association.
WSFI	Wood and Synthetic Flooring Institute.
WWPA	Western Wood Products Association.

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ARCHITECTS**

**SECTION 01 42 00
REFERENCES**

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Visual Mockups; separate or freestanding construction; removal and demolition work.

1.2 VISUAL MOCKUPS

- A. Definitions:
 - 1. Visual Mockup: Separate mockup construction, intended to illustrate materials and workmanship in an assembly, and used for technical and aesthetic evaluation. Mockup shall not to be a part of the finished construction.
 - 2. Integrated Visual Mockup: A single, freestanding visual mockup assembly incorporating elements specified in various Sections, and demonstrating interface of various materials and systems, constructed at the site prior to installation of the actual assembly in the Project. Mockup may be incorporated into the finished construction.
- B. Configuration and Extent of Mockups: As described in this Section and as required to illustrate the design intent for Architect's evaluation.
- C. Maintain and protect Visual Mockups from damage during construction, and dispose of mockups when no longer required, as determined by Architect.

1.3 MOCKUP DESCRIPTION

- A. General: Provide mockups as specified below.
 - 1. Mockup Construction Schedule: Indicate time required for mockup construction, Architect's and County's review and acceptance, and removal/demolition work associated with mockups in Construction Progress Schedule. Refer to Section 01 32 16 "Construction Progress Schedules" requirements.
- B. Colored Concrete Finishing:
 - 1. Colored concrete finishing work shall be performed under provisions of Section 03 35 00 "Colored Concrete Finishing".
 - 2. At location on Project selected by Architect, place and finish an 8 foot x 8 foot x 4 inch deep visual mockup of each concrete finish and color for review by Architect.
 - 3. Construct mockup using processes and techniques intended for use on permanent work, including curing procedures. Include samples of control, construction, and expansion joints in sample panels. Show how different colors will cleanly and sharply abut to each other. Mockup shall be produced by the individual workers who will perform the work for the Project.
 - 4. Accepted mockup shall provide visual standard for work and shall remain through completion of the work for use as a quality standard for finished work.
 - 5. Accepted mock-up may not remain as part of the completed work. Remove after all colored concrete finishing work had been completed and accepted.
- C. Exterior Finishes:
 - 1. Construct Mock-up of exterior wall and roof finishes indicating transitions between materials, top of wall conditions, trim conditions, accent banding, control joints, expansion joints, base of wall conditions, fascia details and finished window conditions.
 - 2. Mock-up shall include a minimum of 32 square feet of each wall and roofing material specified, including:
 - a. Concrete Unit Masonry
 - b. Precast Wall panels

- c. Window/door frames/louvers
- d. Metal soffit and wall panels (at bridge)
- e. Metal Roof Panels
3. Construct mockup using processes and techniques intended for use on permanent work, including curing procedures. Include samples of control, construction, and expansion joints in sample panels. Show how different colors will cleanly and sharply abut to each other. Mockup shall be produced by the individual workers who will perform the work for the Project.
4. Accepted mockup shall provide visual standard for work and shall remain through completion of the work for use as a quality standard for finished work.
5. Accepted mock-up may not remain as part of the completed work.

1.4 QUALITY ASSURANCE

- A. Pre-Installation Meetings: Convene pre-installation meeting at least one week prior to commencing work on Mockups.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 MOCKUP MATERIALS

- A. Contractor is cautioned to not purchase all materials for the project that are involved in any one mockup until after the mockup has been reviewed and accepted by the Architect.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Section includes requirements for temporary utilities, support facilities, and security and protection facilities, including but not limited to:
 - 1. Water service and distribution.
 - 2. Sanitary facilities, including toilets, wash facilities, and drinking water facilities.
 - 3. Heating and cooling facilities.
 - 4. Ventilation.
 - 5. Electric power service.
 - 6. Lighting.
 - 7. Telephone service (Land line)
 - 8. Waste disposal facilities.
 - 9. Field office.
 - 10. Storage and fabrication sheds.
 - 11. Lifts and hoists.
 - 12. Construction aids and miscellaneous services and facilities.
 - 13. Environmental protection.
 - 14. Pest control.
 - 15. Enclosure fence.
 - 16. Security enclosure and lockup.
 - 17. Barricades, warning signs, and lights.
 - 18. Temporary partitions.
 - 19. Fire protection.
 - 20. Accessories necessary for a complete installation.
 - 21. Traffic barricades
 - 22. Encroachment Permits
- B. Construction Facilities: Temporary buildings, vehicular access, parking, project identification, progress cleaning, and fire prevention facilities.
- C. Protection of Work.
- D. Removal of utilities, facilities, and controls.
- E. Use Charges:
 - 1. Installation and removal of and use charges for temporary facilities shall be included in the Contract Sum unless otherwise indicated. Allow other entities to use temporary services and facilities without cost, including, but not limited to, Owner's construction forces, Architect, occupants of Project, testing agencies, and Authorities Having Jurisdiction.
 - 2. Water and Sewer Service: Pay sewer service use charges for water used and sewer usage by all entities for construction operations.
 - 3. Electric Power Service: Pay electric power service use charges for electricity used by all entities for construction operations.

1.2 SUBMITTALS

- A. Site Plan: Show temporary facilities, utility hookups, staging areas, and parking areas for construction personnel.
- B. Moisture Protection Plan: Describe procedures and controls for protecting materials and construction from water absorption and damage.

1. Describe delivery, handling, and storage provisions for materials subject to water absorption or water damage.
 2. Indicate procedures for discarding water damaged materials, protocols for mitigating water intrusion into completed Work, and replacing water damaged work.
 3. Indicate sequencing of work that requires water, such as sprayed fire resistive materials, plastering, and tile grinding, and describe plans for dealing with water from these operations. Show procedures for verifying that wet construction has dried sufficiently to permit installation of finish materials.
- C. Dust and HVAC Control Plan: Submit coordination drawing and narrative that indicates the dust and HVAC control measures proposed for use, proposed locations, and proposed time frame for their operation. Identify further options if proposed measures are later determined to be inadequate. Include the following:
1. HVAC system isolation schematic drawing.
 2. Location of proposed air-filtration system discharge.
 3. Waste handling procedures.
 4. Other dust control measures.

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements:
1. Accessible Temporary Egress: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board ADA-ABA Accessibility Guidelines (ADAAG), ICC/ANSI A117.1, and CBC 2019 California Building Code (CCR Title 24, Part 2, as adopted and amended by DSA).
- B. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.
- C. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.

1.4 TEMPORARY UTILITIES

- A. Temporary Electricity
1. Exercise measures to conserve energy.
 2. Provide power outlets for construction operations, with branch wiring and distribution boxes located as required. Provide flexible power cords as required for portable construction tools and equipment.
 3. Install and maintain temporary distributions of electrical power to locations at the Site as necessary or appropriate for efficient prosecution of the Work. Remove temporary distributions as appropriate or as directed by County.
 4. Provide main service disconnect and overcurrent protection at convenient location.
- B. Temporary Lighting
1. Provide and maintain lighting for construction operations to achieve minimum lighting level of two (2) Lumens per square foot.
 2. Provide and maintain a minimum of one Lumen per square foot of lighting at exterior staging and storage areas after dark for security purposes.
 3. Provide branch wiring from power source to distribution boxes with lighting conductors, pigtails, and lamps for specified lighting levels.
 4. Maintain lighting and provide routine repairs.
- C. Temporary Heating
1. Provide heating devices and heat as needed to maintain specified conditions for

- construction operations. Exercise measures to conserve energy.
2. Maintain minimum ambient temperature of 50 degrees F in areas where construction is in progress, unless indicated otherwise in product Sections.
- D. Temporary Cooling
1. Provide cooling devices and cooling as needed to maintain specified conditions for construction operations. Exercise measures to conserve energy.
 2. Maintain maximum ambient temperature of 80 degrees F in areas where construction is in progress, unless indicated otherwise in specifications.
- E. Temporary Ventilation
1. Ventilate enclosed areas to achieve curing of materials, to dissipate humidity, and to prevent accumulation of dust, fumes, vapors, or gases.
- F. Temporary Telephone Service
1. Provide, maintain and pay for cellular telephone service to field at time of project mobilization and for the duration of the project.
 2. Provide, maintain and pay for internet access field office at time of project mobilization and for the duration of the project.
- G. Temporary Water Service
1. Contractor shall provide and pay for suitable quality water service as needed to maintain specified conditions for construction operations. Connect to nearest water source. Exercise measures to conserve water.
 2. Extend branch piping with outlets located so water is available by hoses with threaded connections. Provide temporary pipe insulation to prevent freezing.
- H. Temporary Sanitary Service/Facilities
1. Provide and maintain required temporary facilities for use by construction personnel. Maintain daily in sanitary and clean condition.

1.5 TEMPORARY FIELD OFFICES AND STORAGE

- A. Offices: Weather-tight, with computer, printer, lighting, electrical outlets, heating, cooling, and ventilating equipment, and equipped with sturdy furniture drawing rack and drawing display table.
- B. Provide space for project meetings, with table and chairs to accommodate a minimum of eight persons.
- C. Locate offices and sheds from new structures so as to not disrupt or interfere with daily operations.
- D. Construction: Portable or mobile buildings, or buildings constructed with floors raised above ground, securely fixed to foundations with steps and landings at entrance doors.
1. Construction: Structurally sound, secure, weather tight enclosures for office and storage spaces. Maintain during progress of Work; remove at completion of Work.
 2. Temperature Transmission Resistance of Floors, Walls, and Ceilings: Compatible with occupancy and storage requirements.
 3. Exterior Materials: Weather resistant.
 4. Interior Materials in Offices: Sheet type materials for walls and ceilings, pre-finished or painted; resilient floors and bases.
 5. Windows: Minimum total area of 10 percent of floor area, with operable sash and insect screens. Locate to provide views of construction area.
 6. Lighting for Offices: 50 foot-candles at desk top height, exterior lighting at entrance

- doors.
7. Interior Materials in Storage Sheds: As required to provide specified conditions for storage of products.
- E. Provide separate temporary facilities located on the construction site for the use of the Contract Administrator, which includes at a minimum a 10' x 40' office trailer furnished with thermostatically controlled HVAC, and a fully functional restroom. Flooring shall be VCT throughout (no carpet), and tamper proof burglar bars installed on the doors and windows. All utilities installation and consumption provided by Contract; which shall include grid-power, broadband internet, water and sanitary waste disposal.
 1. One DSL or other high speed Internet connection
 2. Two (2) desks with side pedestal drawers and four (4) chairs.
 3. Two (2) locking file cabinets with 4 drawers each, legal size.
 - F. Storage Areas And Sheds: Size to storage requirements for products of individual Sections, allowing for access and orderly provision for maintenance and for inspection of products to requirements of Section 01 60 00 "Product Requirements".
 - G. Preparation: Fill and grade sites for temporary structures sloped for drainage away from buildings.
 - H. Installation:
 1. Install office spaces ready for occupancy within 15 days of date fixed in Notice to Proceed.
 - I. Maintenance And Cleaning:
 1. Weekly janitorial services for offices; periodic cleaning and maintenance for office and storage areas.
 2. Maintain approach walks free of mud, water, and snow.
 - J. Removal: At completion of Work remove buildings, foundations, utility services, and debris. Restore areas.

1.6 VEHICULAR ACCESS

- A. Construct temporary all-weather access roads from public thoroughfares to serve construction area, of width and load bearing capacity to accommodate unimpeded traffic for construction purposes.
- B. Extend and relocate vehicular access as Work progress requires, provide detours as necessary for unimpeded traffic flow.
- C. Provide unimpeded access for emergency vehicles. Maintain 20 foot wide driveways with turning space between and around combustible materials.
- D. Provide and maintain access to fire hydrants and control valves free of obstructions.
- E. Provide means of removing mud from vehicle wheels before entering streets.

1.7 PARKING

- A. Coordinate parking areas to accommodate construction personnel with County.
- B. Provide temporary surface parking areas to accommodate construction personnel.

- C. When site space is not adequate, provide additional off-site parking.
- D. Use of designated existing on-site streets and driveways used for construction traffic is not permitted. Tracked vehicles not allowed on paved areas.
- E. Use of existing parking facilities used by construction personnel is not permitted.
- F. Do not allow heavy vehicles or construction equipment in parking areas.
- G. Do not allow vehicle parking on existing pavement.
- H. Permanent Pavements And Parking Facilities:
 - 1. Bases for permanent roads and parking areas may be used for construction traffic.
 - 2. Avoid traffic loading beyond paving design capacity. Tracked vehicles not allowed.
- I. Maintenance:
 - 1. Maintain traffic and parking areas in sound condition.
 - 2. Maintain existing paved areas used for construction; promptly repair breaks, potholes, low areas, standing water, and other deficiencies, to maintain paving and drainage in original, or specified, condition.
- J. Removal, Repair:
 - 1. Remove temporary materials and construction before Project Completion.
 - 2. Repair existing facilities damaged by use, to original condition.

1.8 PROJECT IDENTIFICATION

- A. Project Identification Sign:
 - 1. One painted sign, 32 square foot area, bottom edge at 6 feet above ground.
 - 2. Content:
 - a. Project title and name of County as indicated on Contract Documents.
 - b. Names and titles of authorities.
 - c. Names and titles of Architect and Consultants.
 - d. Name of Prime Contractor and major Subcontractors.
 - 3. Graphic Design, Colors, Style of Lettering: Designated by Architect.
 - 4. No other signs are allowed without County permission except those required by law.
- B. Design sign and structure to withstand 60 miles per hour wind velocity.
- C. Sign Painter: Experienced as professional sign painter for minimum three years.
- D. Finishes, Painting: Adequate to withstand weathering, fading, and chipping for duration of construction.
- E. Show content, layout, lettering, color, structure, sizes, and grades of members.
- F. Sign Materials:
 - 1. Structure and Framing: Wood or metal, structurally adequate.
 - 2. Sign Surfaces: Exterior grade plywood with medium density overlay, minimum 3/4 inches thick, standard large sizes to minimize joints.
 - 3. Rough Hardware: Galvanized.
 - 4. Paint and Primers: Exterior quality, one prime coat and two finish coats; sign background color as selected by Architect.
 - 5. Lettering: Exterior quality paint or pre-cut vinyl self-adhesive products, colors as selected by Architect.

- G. Installation:
 - 1. Install project identification sign within 15 days after date fixed by Notice to Proceed.
 - 2. Erect at designated location.
 - 3. Erect supports and framing on secure foundation, rigidly braced and framed to resist wind loadings.
 - 4. Install sign surface plumb and level, with butt joints. Anchor securely.
 - 5. Paint exposed surfaces of sign, supports, and framing.
- H. Maintenance: Maintain signs and supports clean, repair deterioration and damage.
- I. Removal: Remove signs, framing, supports, and foundations at completion of Project and restore area.

1.9 PROGRESS CLEANING AND WASTE REMOVAL

- A. Maintain areas free of waste materials, debris and rubbish. Maintain site in a clean and orderly condition.
- B. Remove debris and rubbish from pipe chases, plenums, attics, crawl spaces and other closed or remote spaces prior to enclosing the space.
- C. Broom and vacuum clean interior areas prior to start of surface finishing and continue cleaning to eliminate dust.
- D. Remove waste materials, debris and rubbish from site daily and dispose off-site.

1.10 FIRE PREVENTION FACILITIES

- A. Smoking on the job site is prohibited.
- B. Establish fire watch for cutting and welding and other hazardous operations capable of starting fires. Maintain fire watch before, during, and after hazardous operations until threat of fire does not exist.
- C. Portable Fire Extinguishers: NFPA 10; 10 pound capacity, 4A-60B: C UL rating.
 - 1. Provide one fire extinguisher at each stair on each floor of buildings under construction.
 - 2. Provide minimum one fire extinguisher in every construction trailer and storage shed.
 - 3. Provide minimum one fire extinguisher on roof during roofing operations using heat producing equipment.

1.11 BARRIERS AND ENCLOSURES

- A. Provide 6 foot high temporary chain link fence barriers to prevent unauthorized entry to construction areas, and to protect adjacent properties from damage from construction operations and demolition.
- B. Provide protection for plants designated to remain. Replace damaged plants.
- C. Exterior Enclosures: Provide temporary insulated weather tight closure of exterior openings to accommodate acceptable working conditions and protection for products, to allow for temporary heating and maintenance of required ambient temperatures identified in individual specification sections, and to prevent entry of unauthorized persons. Provide access doors with self-closing hardware and locks.

1.12 SECURITY

- A. Provide security and facilities to protect Work and County occupied areas affected by the Work from unauthorized entry, vandalism or theft.
- B. Initiate program at project mobilization. Maintain program throughout construction period until County occupancy.

1.13 WATER CONTROL

- A. Grade site to drain. Maintain excavations free of water. Provide, operate, and maintain pumping equipment.
- B. Protect site from puddling or running water. Provide water barriers as required to protect site from soil erosion.

1.14 DUST CONTROL

- A. Execute Work by methods to minimize raising dust from construction operations.
- B. Provide positive means to prevent air-borne dust from dispersing into atmosphere.

1.15 EROSION AND SEDIMENT CONTROL

- A. Plan and execute construction by methods to control surface drainage from cuts and fills, from borrow and waste disposal areas. Prevent erosion and sedimentation.
- B. Minimize surface area of bare soil exposed at one time.
- C. Provide temporary measures including berms, dikes, and drains, and other devices to prevent water flow.
- D. Construct fill and waste areas by selective placement to avoid erosive surface silts or clays.
- E. Periodically inspect earthwork to detect evidence of erosion and sedimentation; promptly apply corrective measures.

1.16 NOISE CONTROL

- A. Provide methods, means, and facilities to minimize noise produced by construction operations.

1.17 POLLUTION CONTROL

- A. Provide methods, means, and facilities to prevent contamination of soil, water, and atmosphere from discharge of noxious, toxic substances, and pollutants produced by construction operations.
- B. Comply with pollution and environmental control requirements of authorities having jurisdiction.

1.18 PROTECTION OF INSTALLED WORK

- A. Protect installed Work and provide special protection where specified in individual specification Sections.
- B. Provide temporary and removable protection for installed Products. Control activity in

immediate work area to minimize damage.

- C. Provide protective coverings at walls, projections, jambs, sills and soffits of openings.
- D. Protect finished floors, stairs and other surfaces from traffic, dirt, wear, damage or movement of heavy objects, by protecting with durable sheet materials.

1.19 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

- A. Remove temporary above-grade or buried utilities, equipment, facilities, and materials prior to Project Completion.
- B. Clean and repair damage caused by installation or use of temporary work.
- C. Restore existing facilities used during construction to original condition. Restore permanent facilities used during construction to specified condition.

1.20 TEMPORARY SHORING

- A. Shoring shall be in accordance with Cal-Osha Construction safety orders, latest edition.
- B. Temporary retaining structures shall be designed and constructed by the Contractor.
 - 1. Provide design of temporary shoring design by licensed California Civil Engineer, prior to construction.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 PROJECT CONDITIONS

- A. Temporary Use of Permanent Facilities: Engage Installer of each permanent service to assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Owner's acceptance, regardless of previously assigned responsibilities.

3.2 INSTALLATION

- A. Locate facilities where they will serve project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.
 - 1. Locate facilities to limit site disturbance as specified in Section 01 10 00.
- B. Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

3.3 TEMPORARY UTILITY INSTALLATION

- A. Install temporary service. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.
- B. Sewers and Drainage: Provide temporary utilities to remove effluent lawfully.
 - 1. Connect temporary sewers to municipal system as directed by authorities having jurisdiction.

- C. Water Service: Install water service and distribution piping in sizes and pressures adequate for construction.
- D. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking water for use of construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.
 - 1. Disposable Supplies: Provide toilet tissue, paper towels, paper cups, and similar disposable materials for each facility. Maintain adequate supply. Provide covered waste containers for disposal of used material.
 - 2. Wash Facilities: Install wash facilities supplied with potable water at convenient locations for personnel who handle materials that require wash up. Dispose of drainage properly. Supply cleaning compounds appropriate for each type of material handled. Provide safety showers, eyewash fountains, and similar facilities for convenience, safety, and sanitation of personnel.
- E. Heating and Cooling: Provide temporary heating and cooling required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed.
- F. Isolation of Work Areas in Occupied Facilities: Prevent dust, fumes, and odors from entering occupied areas.
 - 1. Prior to commencing Work, isolate the HVAC system in area where Work is to be performed according to coordination drawings.
 - e. Disconnect supply and return ductwork in Work area from HVAC systems servicing occupied areas.
 - f. Maintain negative air pressure within Work area using HEPA equipped air filtration units, starting with commencement of temporary partition construction, and continuing until removal of temporary partitions is complete.
 - 2. Maintain dust partitions during the Work. Use vacuum collection attachments on dust producing equipment. Isolate limited Work within occupied areas using portable dust containment devices.
 - 3. Perform daily construction cleanup and final cleanup using approved, HEPA filter equipped vacuum equipment.
- G. Ventilation and Humidity Control: Provide temporary ventilation required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce ambient condition required and minimize energy consumption.
 - 1. Provide dehumidification systems when required to reduce substrate moisture levels to level required to allow installation or application of finishes.
- H. Electric Power Service: Provide electric power service and distribution system of sufficient size, capacity, and power characteristics required for construction operations. Install electric power service underground unless otherwise indicated.
 - 1. Electric Distribution: Provide receptacle outlets adequate for connection of power tools and equipment.
 - a. Provide waterproof connectors to connect separate lengths of electrical power cords if single lengths will not reach areas where construction activities are in progress. Do not exceed safe length voltage ratio.
 - b. Provide warning signs at power outlets other than 110 to 120 V.
 - c. Provide metal conduit, tubing, or metallic cable for wiring exposed to possible damage. Provide rigid steel conduits for wiring exposed on grades, floors, decks, or traffic areas.
 - d. Provide metal conduit enclosures or boxes for wiring devices.

- e. Provide 4 gang outlets, spaced so 100 foot (30 m) extension cord can reach each area for power hand tools and task lighting. Provide a separate 125-V ac, 20-A circuit for each outlet.

- I. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.
 - 1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.
 - 2. Install lighting for Project identification sign.

- J. Telephone Service: Provide temporary telephone service in common use facilities for use by construction personnel, Architect and inspection services. Install one telephone line(s) for each field office.
 - 1. Provide dedicated telephone line for each facsimile machine in each field office.
 - 2. At each telephone, post a list of important telephone numbers.
 - a. Police and fire departments.
 - b. Ambulance service.
 - c. Contractor's home office.
 - d. Contractor's emergency after-hours telephone number.
 - e. Architect's office.
 - f. Engineers' offices.
 - g. Owner's office.
 - h. Principal subcontractors' field and home offices.
 - 3. Provide superintendent with cellular telephone or portable two-way radio for use when away from field office.

- K. Electronic Communication Service: Provide a desktop computer and printer/scanner in the primary field office adequate for use by Architect, Inspection services and Owner to access Project electronic documents and maintain electronic communications.
 - 1. Internet Service: Broadband modem, router and ISP, equipped with hardware firewall.
 - 2. Internet Security: Integrated software, providing software firewall, virus, spyware, phishing, and spam protection in a combined application.
 - 3. Backup: External hard drive, minimum 1 terabyte, with automated backup software providing daily backups.

3.4 SUPPORT FACILITIES INSTALLATION

- A. Provide construction for temporary offices, shops, and sheds located within construction area or within 30 feet (9 m) of building lines that is noncombustible according to ASTM E 136. Comply with NFPA 241.
 - 1. Maintain support facilities until Architect schedules Substantial Completion inspection. Remove before Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to Owner.

- B. Temporary Use of Permanent Roads and Paved Areas: Locate temporary roads and paved areas in same location as permanent roads and paved areas. Construct and maintain temporary roads and paved areas adequate for construction operations. Extend temporary roads and paved areas, within construction limits indicated, as necessary for construction operations.
 - 1. Coordinate elevations of temporary roads and paved areas with permanent roads and paved areas.
 - 2. Prepare subgrade and install subbase and base for temporary roads and paved areas according to Section 31 20 00 Earthmoving.
 - 3. Recondition base after temporary use, including removing contaminated material, regrading, proof-rolling, compacting, and testing.

4. Delay installation of final course of permanent pavement until immediately before Substantial Completion.
- C. Traffic Controls:
 1. Comply with requirements of authorities having jurisdiction:
 - a. Protect existing site improvements to remain including curbs, pavement, and utilities.
 - b. Maintain access for fire-fighting equipment and access to fire hydrants.
- D. Parking: Provide temporary parking areas for construction personnel.
- E. Dewatering Facilities and Drains: Comply with requirements of authorities having jurisdiction. Maintain Project site, excavations, and construction free of water:
 1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining properties or endanger permanent Work or temporary facilities.
- F. Project Signs:
 1. Provide Project signs as indicated. Unauthorized signs are not permitted:
 - a. Identification Signs: Provide Project identification signs as indicated on Drawings.
 - b. Temporary Signs: Provide other signs as indicated and as required to inform public and individuals seeking entrance to Project.
 - 1) Provide temporary, directional signs for construction personnel and visitors.
 - c. Maintain and touchup signs so they are legible at all times.
- G. Waste Disposal Facilities: Provide waste collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of authorities having jurisdiction. Comply with progress cleaning requirements in Section 01 73 00.
- H. Lifts and Hoists: Provide facilities necessary for hoisting materials and personnel.
 1. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.
- I. Temporary Elevator Use: Use of existing elevators located in the jail is not permitted.
- J. Temporary Stairs: Until permanent stairs are available, provide temporary stairs where ladders are not adequate.
- K. Temporary Use of Permanent Stairs: Use of new stairs for construction traffic will be permitted, provided stairs are protected and finishes restored to new condition at time of Substantial Completion.

3.5 SECURITY AND PROTECTION FACILITIES INSTALLATION

- A. Protection of Existing Facilities: Protect existing vegetation, equipment, structures, utilities, and other improvements at Project site and on adjacent properties, except those indicated to be removed or altered. Repair damage to existing facilities to the satisfaction of Owner and Architect.
- B. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.
- C. Temporary Erosion and Sedimentation Control: Provide measures to prevent soil erosion and discharge of soil bearing water runoff and airborne dust to undisturbed areas and to adjacent properties and walkways, according to requirements of authorities having

- jurisdiction.
1. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross tree or plant protection zones.
 2. Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.
 3. Clean, repair, and restore adjoining properties and roads affected by erosion and sedimentation from Project site during the course of Project.
 4. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.
- D. Stormwater Control: Comply with requirements of Authorities Having Jurisdiction. Provide barriers in and around excavations and subgrade construction to prevent flooding by runoff of stormwater from heavy rains.
- E. Tree and Plant Protection: Install temporary fencing located as indicated or outside the drip line of trees to protect vegetation from damage from construction operations. Protect tree root systems from damage, flooding, and erosion.
- F. Pest Control: Engage pest control service to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests and to perform extermination and control procedures at regular intervals so Project will be free of pests and their residues at Substantial Completion. Perform control operations lawfully, using environmentally safe materials.
- G. Site Enclosure Fence: Before construction operations begin provide site enclosure fence to prevent people and animals from easily entering site except by entrance gates.
1. Extent of Fence: As required to enclose entire Project site or portion determined sufficient to accommodate construction operations.
- H. Security Enclosure and Lockup: Install temporary enclosure around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security. Lock entrances at end of each Work day.
- I. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.
- J. Temporary Egress: Maintain temporary egress from existing occupied facilities as indicated and as required by authorities having jurisdiction.
- K. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.
1. Where heating or cooling is needed and permanent enclosure is incomplete, insulate temporary enclosures.
- L. Temporary Partitions: Provide floor to ceiling dustproof partitions to limit dust and dirt migration and to separate occupied areas occupied from fumes and noise:
1. Construct dustproof partitions with gypsum wallboard with joints taped on occupied side, and fire retardant treated plywood on construction operations side.
 2. Construct dustproof partitions with two layers of 6 mil (0.14 mm) polyethylene sheet on each side. Cover floor with two layers of 6 mil (0.14 mm) polyethylene sheet, extending sheets 18 inches (460 mm) up the sidewalls. Overlap and tape full length of joints. Cover floor with fire retardant treated plywood. Do not apply tape to finish floor surfaces.

- a. Construct vestibule and airlock at each entrance through temporary partition with not less than 48 inches (1219 mm) between doors. Maintain water dampened foot mats in vestibule.
 3. Where fire resistance rated temporary partitions are indicated or are required by authorities having jurisdiction, construct partitions according to the rated assemblies.
 4. Insulate partitions to control noise transmission to occupied areas.
 5. Seal joints and perimeter. Equip partitions with gasketed dustproof doors and security locks where openings are required.
 6. Protect air handling equipment.
 7. Provide walk off mats at each entrance through temporary partition.
- M. Temporary Fire Protection: Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241; manage fire-prevention program:
1. Prohibit smoking in construction areas.
 2. Supervise welding operations, combustion type temporary heating units, and similar sources of fire ignition according to requirements of authorities having jurisdiction.
 3. Develop and supervise an overall fire prevention and protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.
 4. Provide temporary standpipes and hoses for fire protection. Hang hoses with a warning sign stating that hoses are for fire protection purposes only and are not to be removed. Match hose size with outlet size and equip with suitable nozzles.

3.6 MOISTURE AND MOLD CONTROL

- A. Contractor's Moisture Protection Plan: Avoid trapping water in finished Work. Document visible signs of mold that may appear during construction.
- B. Exposed Construction Phase: Before installation of weather barriers, when materials are subject to wetting and exposure and to airborne mold spores, protect as follows:
 1. Protect porous materials from water damage.
 2. Protect stored and installed material from flowing or standing water.
 3. Keep porous and organic materials from coming into prolonged contact with concrete.
 4. Remove standing water from decks.
 5. Keep deck openings covered or dammed.
- C. Partially Enclosed Construction Phase: After installation of weather barriers but before full enclosure and conditioning of building, when installed materials are still subject to infiltration of moisture and ambient mold spores, protect as follows:
 1. Do not load or install drywall or other porous materials or components, or items with high organic content, into partially enclosed building.
 2. Keep interior spaces reasonably clean and protected from water damage.
 3. Periodically collect and remove waste containing cellulose or other organic matter.
 4. Discard or replace water-damaged material.
 5. Do not install material that is wet.
 6. Discard, replace, or clean stored or installed material that begins to grow mold.
 7. Perform Work in a sequence that allows any wet materials adequate time to dry before enclosing the material in drywall or other interior finishes.
- D. Controlled Condition Phase of Construction: After completing and sealing of the building enclosure but prior to the full operation of permanent HVAC systems, maintain as follows:
 1. Control moisture and humidity inside building by maintaining effective dry-in conditions.
 2. Use permanent HVAC system to control humidity.
 3. Comply with manufacturer's written instructions for temperature, relative humidity, and

exposure to water limits and moisture control.

- a. Hygroscopic materials that may support mold growth, including wood and gypsum based products, which become wet during the course of construction and remain wet for 48 hours are considered defective and are to be removed and replaced.
- b. Measure moisture content of materials that have been exposed to moisture during construction operations or after installation. Record readings beginning at time of exposure and continuing daily for 48 hours. Identify materials containing moisture levels higher than allowed. Report findings in writing to Architect.
- c. Remove materials that cannot be completely restored to their manufactured moisture level within 48 hours.

3.7 OPERATION, TERMINATION, AND REMOVAL

- A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.
- B. Maintenance:
 1. Maintain facilities in good operating condition until removal:
 - a. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24 hour basis where required to achieve indicated results and to avoid possibility of damage.
- C. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion unless otherwise required and approved by Owner and Architect.
- D. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
 1. Materials and facilities that constitute temporary facilities are property of Contractor. Owner reserves right to take possession of Project identification signs.
 2. Remove temporary roads and paved areas not intended for or acceptable for integration into permanent construction. Where area is intended for landscape development, remove soil and aggregate fill that do not comply with requirements for fill or subsoil. Remove materials contaminated with road oil, asphalt and other petrochemical compounds, and other substances that might impair growth of plant materials or lawns. Repair or replace street paving, curbs, and sidewalks at temporary entrances, as required by authorities having jurisdiction.
 3. At Substantial Completion, repair, renovate, and clean permanent facilities used during construction period. Comply with final cleaning requirements specified in Section 01 77 22.

END OF SECTION

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall provide all materials, equipment, and labor necessary to furnish, place, and maintain all temporary traffic control systems, including construction and maintenance area traffic control devices and flaggers as required to perform the Work in accordance with this Section, and all other appurtenant Work, complete in place, as shown on the Contract Drawings and as specified herein.
- B. Work Specified in this Section
 - 1. Review of proposed Work areas to determine temporary traffic control requirements.
 - 2. Verification of temporary traffic controls with the Project Engineer or the Owner prior to implementation.
 - 3. Maintenance of traffic control during the Work.
 - 4. Monitoring traffic control during the Work to determine necessary changes required to maintain adequacy.
 - 5. Maintenance of traffic control during non-work hours to maintain adequacy.
 - 6. Removal of temporary traffic control systems after completion of the Work.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. General Provisions, Section B-51 – Public Convenience.
- B. City of Eureka Public Works Encroachment Permit.
- C. State of California, Department of Transportation Encroachment Permit.
- D. State of California, Department of Transportation (Caltrans) Specifications and Standards
 - 1. Standard Specifications
 - a. Section 7 Legal Relations and Responsibility
 - b. Section 12 Construction Area Traffic Control Devices
 - 2. Standard Plans
 - a. Temporary Traffic Control Systems
 - 3. California Manual on Uniform Traffic Control Devices, Current Edition (California MUTCD)
- E. Commercial Standards
 - 1. State of California, Division of Industrial Safety, Department of Industrial Relations.
 - 2. Safety Orders of the Division of Industrial Safety, Department of Industrial Relations of the State of California, current edition.

1.3 CONTRACTOR SUBMITTALS

- A. The Contractor shall provide the following at least 10 working days prior to excavation and shall meet with the approval of the Owner:
 - 1. The Contractor shall submit for review by the Engineer, a Work Zone Traffic Control Plan on 11" x 17" format which contains only information specifically related to work zone traffic control, including pedestrian traffic control. The plan will show which California MUTCD typical applications are to be used for each work operation in addition to site specific traffic control. If the Contractor proposed to use the current edition of California MUTCD in specific work operations, they shall submit in writing for consideration which

Typical Application Diagram will be used for each work operation. The Work Zone Traffic Control Plan shall include:

- a. Specific details for construction staging, including the location and limits of the work zone.
 - b. Identification of changeable message board locations, if required.
 - c. Locations of all excavations.
 - d. American's with Disabilities Act (ADA) compliant pedestrian routing plans and details showing how pedestrians will be routed through the work area.
 - e. Plans for protection of the public from construction-related hazards.
 - f. Lane closures and traffic routing including consideration of construction-related trucking routes.
 - g. Lane closure markings, barricade locations, and sign locations showing the necessary signing, methods of delineation and channelization and reference to the appropriate Caltrans standards and California MUTCD details for all affected roads.
 - h. Dimensions of lanes affected by traffic control that will be open to traffic.
 - i. Dimensions and locations of signs and cone tapers.
 - j. Identification of side streets and driveways affected by construction and show how they will be handled.
 - k. Detail of how public transit will be handled through the construction area.
 - l. Time periods of lane closures and detours.
2. The Work Zone Traffic Control Plan shall contain a title block which contains the Contractor's name, address, phone number, project superintendent's name, contract name, dates and hours traffic control will be in effect, and a space for review acknowledgment.
 3. The Work Zone Traffic Control Plan shall be prepared by a licensed California Civil or Traffic Engineer. The Work Zone Traffic Control Plan shall be submitted to the Engineer and other affected agencies for review at least two weeks prior to implementation in order to determine the Contractor's compliance with the requirements of this section.
 4. No work except for installation of project identification signs will be allowed to commence prior to approval of the Work Zone Traffic Control Plan.
 5. A "Letter of Responsibility," on company letterhead, indicating the names and telephone numbers of at least three different persons who shall be available to be contacted in case of emergency at any time during the life of the contract. Said persons must have decision-making authority within the company.

PART 2 PRODUCTS

2.1 GENERAL

- A. All construction area stationary and portable sign panels, lights, barricades, and traffic control devices shall be the product of a commercial sign or safety device manufacturer conforming to the requirements of Section 12, "Construction Area Traffic Control Devices," of the Caltrans Standard Specifications, unless otherwise specified in this Section, shown on the Drawings, and/or as directed by the Engineer.

PART 3 EXECUTION

3.1 GENERAL

- A. No work shall commence until traffic control signing has been approved by the Engineer.

- B. The Contractor shall provide all appropriate traffic control measures in accordance with this Section prior to start of construction in the public right-of-way or in any area adjacent to the street right of way where public safety is affected.
- C. The Contractor shall take all necessary precautions for the protection of the Work and the safety of its employees and the public. Traffic shall be maintained through the construction or maintenance zone in accordance with Sections 7-1.08, 7-1.09 and 12 of the Caltrans Standard Specifications and Sections 01 10 00 "Summary of Work."
- D. Field changes to traffic control plans shall be approved by the Engineer prior to installation.
- E. When traffic cones or delineators are used to delineate a temporary edge of a traffic lane, the line of cones or delineators shall be considered to be the edge of the traffic lane, however, the Contractor shall not reduce the width of an existing lane to less than 10 feet without written approval from the Engineer.
- F. All construction area signs, lights, barricades, and traffic control devices shall be furnished, installed, maintained, and removed in conformance with the latest edition of the California MUTCD. Additional or alternate signs may only be used when specifically authorized by the Engineer.
- G. The Contractor shall monitor traffic and safety conditions and maintain adequate traffic control measures during both work and non-work hours in order to maintain compliance with the requirements of this Section.
- H. The Contractor shall conform to all requirements of the current "Safety Orders of the Division of Industrial Safety, Department of Industrial Relations of the State of California."
- I. If a hazardous condition is observed and the Engineer notifies the Contractor either directly or by telephone, the Contractor shall correct the condition immediately. If the Contractor fails to correct the hazardous condition immediately, the Owner reserves the right to call in a local contractor to perform the necessary work needed to improve public safety. The cost incurred shall be billed to the Contractor. Should the Engineer point out any inadequacy of warning and protective measures, such action on the part of the Engineer shall not relieve the Contractor from responsibility for public safety nor abrogate his obligation to furnish and pay for these devices.
- J. All construction area signs, lights, barricades, and temporary traffic control devices shall be completely removed from the roadway when not in use. Locations and methods of storing traffic control equipment adjacent to the roadway between interrupted use shall require prior approval of the Engineer.
- K. The Contractor shall completely remove all temporary signs, striping and/or delineators and restore the pavement, as necessary, upon removal or relocation of any temporary traffic controls or detours constructed as part of the Work.
- L. Temporary traffic control measures shall be in effect only during Work hours. Normal traffic routing shall be reestablished at the end of each workday.
- M. Contractor shall conduct his operation as to offer the least possible obstruction and inconvenience to the public, and he shall have under construction no greater amount of Work than he can prosecute properly with due respect to the rights of the public. Contractor shall provide personal advance notice to each affected resident or business informing him of impending work and provide ample time to remove vehicles and estimated time of driveway closure. This shall be accomplished by delivering a notice to all houses or businesses to be

affected by the impending work. The notice shall be typed and signed by the contractor or his designated superintendent. The format and contents of the notice shall be approved by the Engineer prior to commencement of the Work.

- N. Construction operations shall be conducted in such a manner as to cause as little inconvenience as possible to abutting property owners. Convenient access to driveways, houses, and buildings along the line of the work shall be maintained, and temporary approaches to crossings or intersecting roads shall be provided and kept in good condition.
- O. Whenever the Contractor's operations create a condition hazardous to the public, furnish, erect, and maintain such fences, barricades, lights, signs and other devices as are necessary to prevent accidents or damage or injury to the public.
- P. Should the Contractor appear to be neglectful or negligent in furnishing warning and productive measures as above specified, the Engineer may direct attention to the existence of hazard, and the necessary warning and protective measures shall be furnished and installed by the Contractor at his expense, without cost to the Owner. Should the Engineer point out any inadequacy of warning and protective measures, such action on the part of the Engineer shall not relieve the Contractor from responsibility for public safety nor abrogate his obligation to furnish and pay for these devices.
- Q. Under no circumstances shall access to businesses or residences be held up more than 30 minutes at any one time. The Contractor may coordinate with property and business owners to schedule work so that longer delays do not adversely affect residents or business owners to their satisfaction. In addition, Contractor shall give personal notice to all affected property owners as specified in paragraph M, hereinbefore. Before closing any street to through traffic, Contractor shall obtain prior approval from the Engineer seven (7) days in advance of closure. Contractor shall at all times provide access to public facilities such as schools, etc. and make provisions for passage of emergency vehicles.
- R. No road closures are allowed. The Contractor shall keep Humboldt County Public Works Department, City of Eureka, Caltrans, and all local businesses on Highway 101 within the Project area informed regarding traffic control operations. The Contractor shall call the Humboldt Bay Fire Department at (707) 441-4000, and inform the local businesses before and after any single lane closures on multiple lane local streets within the County or Caltrans right-of-way traffic control activities. This requirement applies immediately upon lane closure for that day and again immediately after removal of the lane closure.

3.2 PEDESTRIAN TRAFFIC

- A. The Contractor is directed to Chapter 6D, Pedestrian and Worker Safety, in the California MUTCD, the Drawings, and these Specifications.
- B. Pedestrians shall be provided with a safe, convenient and accessible path that, at a minimum, replicates the most desirable characteristics of the existing sidewalk, path or footpath.
- C. The Contractor shall construct and maintain temporary pedestrian pathways through the work zone, where required, that shall be in compliance with the requirements of the Americans with Disabilities Act (ADA) and the California MUTCD.
- D. Pedestrian routes shall not be impacted for the purposes of any non-construction activities such as parking of vehicles or equipment, or stock piling of materials.
- E. Pedestrians shall not be led into conflicts with work site vehicles, equipment or operations.

END OF SECTION

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes general protection and pruning of existing trees and plants that are affected by execution of the Work, whether temporary or permanent construction.

1.2 DEFINITIONS

- A. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction.
- B. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction.
- C. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.3 QUALITY ASSURANCE

- A. Preinstallation Conference:
 - 1. Review methods and procedures related to temporary tree and plant protection including, but not limited to, the following:
 - a. Construction schedule. Verify availability of materials, personnel, and equipment needed to make progress and avoid delays.
 - b. Enforcing requirements for protection zones.
 - c. Arborist's responsibilities.
 - d. Field quality control.

1.4 PROJECT CONDITIONS

- A. The following practices are prohibited within protection zones:
 - 1. Storage of construction materials, debris, or excavated material.
 - 2. Parking vehicles or equipment.
 - 3. Foot traffic.
 - 4. Erection of sheds or structures.
 - 5. Impoundment of water.
 - 6. Excavation or other digging unless otherwise indicated.
 - 7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.
- B. Do not direct vehicle or equipment exhaust toward protection zones.
- C. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones and organic mulch.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Protection-Zone Fencing: Fencing fixed in position and meeting the following requirements.
 - 1. Plastic Protection-Zone Fencing: Plastic construction fencing constructed of high-density extruded and stretched polyethylene fabric with 2-inch maximum opening in pattern and weighing a minimum of 0.4 lb/ft.; remaining flexible; inert to most chemicals and acids;

minimum tensile yield strength of 2000 psi and ultimate tensile strength of 2680 psi; secured with plastic bands or galvanized-steel or stainless-steel wire ties; and supported by tubular or T-shape galvanized-steel posts spaced not more than 8 feet apart.

- a. Height: Four (4) feet.
- b. Color: High-visibility orange, nonfading.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Erosion and Sedimentation Control: Examine the site to verify that temporary erosion- and sedimentation-control measures are in place. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.
- B. For the record, prepare written report, endorsed by arborist, listing conditions detrimental to tree and plant protection.

3.2 PREPARATION

- A. Locate and clearly identify trees to remain. Flag each tree trunk at 54 inches above the ground.
- B. Protect tree root systems from damage caused by runoff or spillage of noxious materials while mixing, placing, or storing construction materials. Protect root systems from ponding, eroding, or excessive wetting caused by dewatering operations.

3.3 TREE- AND PLANT-PROTECTION ZONES

- A. Protection-Zone Fencing: Install protection-zone fencing along edges of protection zones in a manner that will prevent people and animals from easily entering protected area. Wherever possible protection-zone fencing shall be placed at or outside of the dripline of trees to be protected. Construct fencing so as not to obstruct safe passage or visibility at vehicle intersections where fencing is located adjacent to pedestrian walkways or in close proximity to street intersections, drives, or other vehicular circulation.
- B. Maintain protection zones free of weeds and trash.
- C. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations. Replacement plants shall be of a similar size and landscape value to those lost and shall be installed in a manner approved by the Architect.
- D. Maintain protection-zone fencing and signage in good condition as acceptable to Architect and remove when construction operations are complete and equipment has been removed from the site.
 1. Do not remove protection-zone fencing, even temporarily, to allow deliveries or equipment access through the protection zone.
 2. Temporary access is permitted subject to preapproval in writing by arborist if a root buffer effective against soil compaction is constructed as directed by arborist. Maintain root buffer so long as access is permitted.

3.4 EXCAVATION

- A. General: Excavate at edge of protection zones and for trenches indicated within protection zones.

- B. Trenching near Trees: Where utility trenches are required within protection zones, hand excavate under or around tree roots or tunnel under the roots by drilling, auger boring, or pipe jacking. Do not cut main lateral tree roots or taproots; cut only smaller roots that interfere with installation of utilities. Cut roots as required for root pruning.
- C. Do not allow exposed roots to dry out before placing permanent backfill. Provide temporary earth cover or pack with peat moss and wrap with burlap. Water and maintain in a moist condition. Temporarily support and protect roots from damage until they are permanently relocated and covered with soil.

3.5 ROOT PRUNING

- A. Prune roots that are affected by temporary and permanent construction. Prune roots as follows:
 - 1. Cut roots manually by digging a trench and cutting exposed roots with sharp pruning instruments; do not break, tear, chop, or slant the cuts. Do not use a backhoe or other equipment that rips, tears, or pulls roots.
 - 2. Cut Ends: Do not paint cut root ends.
 - 3. Temporarily support and protect roots from damage until they are permanently redirected and covered with soil.
 - 4. Cover exposed roots with burlap and water regularly.
 - 5. Backfill as soon as possible.
- B. Root Pruning at Edge of Protection Zone: Prune roots flush with the edge of the protection zone, by cleanly cutting all roots to the depth of the required excavation.
- C. Root Pruning within Protection Zone: Clear and excavate by hand to the depth of the required excavation to minimize damage to root systems. Use narrow-tine spading forks, comb soil to expose roots, and cleanly cut roots as close to excavation as possible.

3.6 CROWN PRUNING

- A. Prune branches that are affected by temporary and permanent construction. Prune branches as follows:
 - 1. Prune trees to remain to compensate for root loss caused by damaging or cutting root system. Provide subsequent maintenance during Contract period as recommended by arborist.
 - 2. Cut branches with sharp pruning instruments; do not break or chop.
 - 3. Do not apply pruning paint to wounds.
- B. Remove branches and dispose of off-site.

3.7 REGRADING

- A. Lowering Grade within Protection Zone: Where new finish grade is indicated below existing grade around trees, slope grade away from trees as recommended by arborist unless otherwise indicated.
 - 1. Root Pruning: Prune tree roots exposed by lowering the grade. Do not cut main lateral roots or taproots; cut only smaller roots. Cut roots as required for root pruning.
- B. Raising Grade: Where new finish grade is indicated above existing grade around trees, slope grade beyond the protection zone. Maintain existing grades within the protection zone.
- C. Minor Fill within Protection Zone: Where existing grade is 2 inches or less below elevation of

finish grade, fill with topsoil. Place topsoil in a single uncompacted layer and hand grade to required finish elevations.

3.8 REPAIR AND REPLACEMENT

- A. General: Repair or replace trees indicated to remain or be relocated that are damaged by construction operations, in a manner approved by Architect.
 - 1. Submit details of proposed root cutting and tree repairs.
 - 2. Have arborist perform the root cutting, branch pruning, and damage repair of trees.
 - 3. Treat damaged trunks, limbs, and roots according to arborist's written instructions.
 - 4. Perform repairs within 24 hours.
 - 5. Replace vegetation that cannot be repaired and restored to full-growth status, as determined by Architect.

- B. Trees: Remove and replace trees indicated to remain that are more than 25 percent dead or in an unhealthy condition that are damaged during construction operations that the Architect determines are incapable of restoring to normal growth pattern.
 - 1. Provide new trees of same size and species as those being replaced or as directed by the Architect.
 - 2. Plant and maintain new trees.

- C. Soil Aeration: Where directed by Architect, aerate surface soil compacted during construction. Aerate ten (10) feet beyond drip line and no closer than 36 inches to tree trunk. Drill 2-inch- diameter holes a minimum of 12 inches deep at 24 inches o.c. Backfill holes with an equal mix of augured soil and sand.

3.9 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Disposal: Remove excess excavated material, displaced trees, trash and debris, and legally dispose of them off County's property.

END OF SECTION

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes: Administrative and procedural requirements for selection of products, including but not limited to:
 - 1. Products.
 - 2. Product Delivery Requirements.
 - 3. Product Storage and Handling Requirements.
 - 4. Product Options.
 - 5. Product Selection Procedures.
 - 6. Product Substitution Procedures.
 - 7. Comparable Products.

1.2 DEFINITIONS

- A. Products: Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term *product* includes the terms *material*, *equipment*, *system*, *assembly*, and terms of similar intent.
 - 1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature current as of date of the Contract Documents.
 - 2. New Products: Items that have not previously been incorporated into another project or facility. Products salvaged or recycled from other projects are not considered new products.
 - 3. Comparable Product: Product that is demonstrated and approved through submittal process to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
- B. Basis of Design Product Specification: A specification in which a specific manufacturer's product is named and accompanied by the words *basis of design product*, including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of additional manufacturers named in the specification.

1.3 SUBMITTALS

- A. Comparable Product Requests: Submit request for consideration of each comparable product. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
 - 1. Include data to indicate compliance with the specified requirements.
 - 2. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within one week of receipt of a comparable product request. Architect will notify Contractor of approval or rejection of proposed comparable product request within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.
 - a. Form of Approval: As specified in Section 01 33 00 Submittal Procedures.
 - b. Use product specified if Architect does not issue a decision on use of a comparable product request within time allocated.
- B. Basis of Design Product Specification Submittal: Comply with requirements in Section 01 33 00 Submittal Procedures. Show compliance with requirements.

1.4 QUALITY ASSURANCE

- A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options.
 - 1. Each contractor is responsible for providing products and construction methods compatible with products and construction methods of other contractors.
 - 2. If a dispute arises between contractors over concurrently selectable but incompatible products, Architect will determine which products shall be used.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.
- B. Delivery and Handling:
 - 1. Schedule delivery to minimize long term storage at site and to prevent overcrowding of construction spaces.
 - 2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
 - 3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
 - 4. Inspect products on delivery to determine compliance with the Contract Documents and to determine that products are undamaged and properly protected.
- C. Storage:
 - 1. Store products to allow for inspection and measurement of quantity or counting of units.
 - 2. Store materials in a manner that will not endanger Project structure.
 - 3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
 - 4. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
 - 5. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
 - 6. Protect stored products from damage and liquids from freezing.
 - 7. Provide a secure location and enclosure at site for storage of materials and equipment by Owner's construction forces. Coordinate location with Owner.

1.6 PRODUCT WARRANTIES

- A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
 - 1. Manufacturer's Warranty: Written warranty furnished by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
 - 2. Warranty: Written warranty required by the Contract Documents to provide specific rights for Owner.
- B. Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.

1. Specified Form: When specified forms are included with the Specifications, prepare a written document using indicated form properly executed.
 2. See other Sections for specific content requirements and particular requirements for submitting special warranties.
- C. Submittal Time: Comply with requirements in Section 01 77 00 Closeout Procedures.

1.7 PRODUCTS

- A. Products: Means new material, machinery, components, equipment, fixtures, and systems forming the Work. Does not include machinery and equipment used for preparation, fabrication, conveying and erection of the Work. Products may also include existing materials or components required for reuse.
- B. All products shall be new, of first class quality, and shall be delivered, installed, connected and finished in every detail, and shall be so selected and arranged as to fit correctly into the proper spaces. Where no specific kind or quality of material is given, a first-class standard article as approved by Architect shall be furnished. Contractor shall provide satisfactory evidence as to the kinds and quality of material and workmanship.
- C. Do not use materials and equipment removed from existing premises, except as specifically permitted by the Contract Documents.
- D. Furnish interchangeable components from same manufacturer for components being replaced.

1.8 PRODUCT DELIVERY REQUIREMENTS

- A. Transport and handle products in accordance with manufacturer's instructions.
- B. Delivery of materials to the Project site shall be coordinated by and received by Contractor or his representative, and stored in secured areas as agreed upon at the job start meeting.
- C. Promptly inspect shipments to assure that products comply with requirements, quantities are correct and products are undamaged.
- D. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement or damage.
- E. Contractor shall take into consideration the available space and location of work site when delivery of materials is necessary.

1.9 PRODUCT STORAGE AND HANDLING REQUIREMENTS

- A. Store and protect products in accordance with manufacturer's instructions, with seals and labels intact and legible. Store sensitive products in weather tight, climate controlled, enclosures in an environment favorable to product.
- B. For exterior storage of fabricated products, place on sloped supports above ground.
- C. Provide off-site storage and protection when site does not permit on-site storage or protection.
- D. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to avoid condensation and degradation of products.

- E. Store loose granular materials on solid flat surfaces in well-drained area. Prevent mixing with foreign matter.
- F. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.
- G. Arrange storage of products to permit access for inspection. Periodically inspect to assure products are undamaged and are maintained under specified conditions.
- H. Contractor shall be responsible to provide all new materials in unopened manufacturer's original containers and deliver such items to Project site in good condition for use on this project. Contractor shall be responsible to store all new materials received as per manufacturer recommendations. Any and all materials discovered to be improperly stored and/or damaged will be replaced at the sole expense to Contractor. Any requests for delays or extension of the Contract Time due to the above will not be considered.
- I. Contractor shall use all means necessary to protect all materials before, during and after installation and to protect the installed work and materials of all other trades and of existing structures. In event of damage, Contractor is to immediately make all repairs and replacements necessary using compatible and like materials.

1.10 PRODUCT OPTIONS

- A. Products Specified by Reference Standards or by Description Only: Any product meeting those standards or description.
- B. Products Specified by Naming One Manufacturer and stating "No Substitutions Allowed, County's Standard": Products of manufacturer named and meeting specifications, no options or substitutions allowed.
- C. Products Specified by Naming One or More Manufacturers without naming a Product, with a Provision for Substitutions: Submit a request for substitution for any manufacturer not named.
- D. Products specified by Naming One or More Manufacturers and Naming Product(s) by the first listed Manufacturer, with a Provision for Substitutions: Submit a request for substitution for any product, by any manufacturer, listed or not listed, other than the product(s) listed.

1.11 PRODUCT SUBSTITUTION PROCEDURES

- A. County will consider requests for Substitutions up to 35 days after the project has been awarded.
- B. Reference to any product, material, equipment, article, system, service or patented process, by trade, catalogue number, name brand product or product manufacturer is for information only and shall not be construed as limiting competition.
- C. Substitutions will only be considered when one or more of the following conditions are met:
 - 1. All aspects of the proposed substitution meet or exceed the criteria for the specified product.
 - 2. The proposed changes are in keeping with the general intent of the Contract Documents.
 - 3. The request is fully documented and timely and properly submitted.
 - 4. The specified product cannot be provided within the Contract Time.
 - 5. The request is directly related to a "comparable" clause or similar language in the

Contract Documents.

6. The request offers County a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities that County must assume. County's additional responsibilities may include, but not be limited to, compensation to Architect for redesign and/or evaluation services and increased cost of other construction by County.
 7. The specified product becomes unavailable through no fault of Contractor.
 8. The specified product cannot receive necessary approvals by governing authorities, and the requested substitution can be approved by governing authorities in a timely manner.
 9. It can be demonstrated that the specified product cannot be provided in a manner that is compatible with other materials and Contractor certifies that the proposed substitution will overcome the incompatibility.
 10. It can be demonstrated that the specified product cannot be coordinated with other materials and Contractor certifies that the proposed substitution can be coordinated.
 11. The specified product cannot provide the warranty required by the Contract Documents and Contractor certifies that the proposed substitution provides the required warranty.
- D. Substitutions will not be considered when one or more of the following conditions occur:
1. Acceptance would require revisions to the Contract Documents, Contract Time extensions or an increase in the Contract Sum.
 2. They are indicated or implied on shop drawing or product data submittals, without separate written request.
 3. When the specified product cannot be provided as a result of failure of Contractor to pursue the Work in a timely manner or properly coordinate construction activities.
- E. In those cases where the Specifications designate a product, material, equipment, article, system, service or patented process by specific brand or trade name and there is only one brand or trade name listed, the item involved is:
1. Required to be used since it is a unique or novel product application, or
 2. Required to match other products in use by County, or
 3. Is the only brand or trade name known to Architect.
- F. Document each request on Substitution Request Form attached at the end of this Section with complete data substantiating compliance of proposed Substitution with the Contract Documents. The burden of proof as to comparative quality, suitability and performance of proposed product(s), material(s), equipment, article(s), system(s), service(s) or patented process(es) shall be upon Contractor. Architect will be the sole judge of the equality of the proposed substitution versus the specified item(s).
- G. A substitution request constitutes a representation that Contractor:
1. Has investigated proposed product and determined that it meets or exceeds the quality level of the specified product.
 2. Will provide the same warranty for the Substitution as for the specified product.
 3. Will coordinate installation and make changes to other Work which may be required for the Work to be complete with no additional cost to County.
 4. Waives claims for additional costs or time extensions which may subsequently become apparent.
 5. Will reimburse County for review services associated with approvals by authorities having jurisdiction.
- H. Substitution Submittal Procedure:
1. Submit request for Substitution electronically for consideration. Limit each request to one proposed Substitution.
 2. Submit shop drawings, product data, and certified test results attesting to the proposed product equivalence.
 3. County will notify Contractor, in writing, of decision to accept or reject request.

4. Incomplete Substitution Request package will not be reviewed and will be returned to Contractor. Contractor shall then provide the specified item.
5. Only one request for substitution will be allowed. If proposed substitution is not accepted by Architect, Contractor shall provide the specified item.
6. Use of accepted substitutions shall in no way relieve Contractor from responsibility for compliance with Drawings and Specifications. The use of accepted substitutions will assume that all extra costs caused by the use of such substitutions where they affect other work or trades shall be borne by the Contractor.
7. All substitutions affecting structural or fire/life safety items will require approval from authority having jurisdiction prior to fabrication and installation on the project.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Materials furnished shall be new and never been used before, unless specified otherwise, and will satisfy the requirements herein and all specifications referenced by provisions within these specifications. Contractor shall furnish, upon request of Project Manager, an affidavit from the manufacturer or supplier to the effect that materials furnished shall conform to the General Conditions, the latest revision of AWWA Specifications, ASTM, and Federal Specifications that pertain. All materials shall be installed in accordance with manufacturer's recommendations and the Standard Drawings and Specifications that pertain. Material for one specific product shall be one manufacturer unless otherwise approved by Architect. All materials shall be subject to inspection after delivery to the site and during installation of the Work. Failure of the Inspector, Project Manager or Architect to note faulty material shall not relieve Contractor of the responsibility for removing or replacing any such material at no additional cost to County.
- B. For the ease of maintenance and parts replacement, to the maximum extent possible use materials of a single manufacturer, delivered in manufacturer's original, unopened containers with labels intact and legible, and in sufficient quantity to allow continuity of work. Deviation from this requirement shall require written approval from County.
- C. County reserves the right to reject any materials list which contains materials from various manufacturers if suitable materials can be secured from fewer manufacturers and to require that source of materials be unified to maximum extent possible.

2.2 PRODUCT SELECTION PROCEDURES

- A. Product Requirements: Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.
 1. Provide products complete with accessories, trim, finish, fasteners, and items needed for complete installation and indicated use and effect.
 2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
 3. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
 4. Where products are accompanied by the term as selected, Architect will make selection.
 5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.
- B. Product Selection Procedures:
 1. Product: Where Specifications name a single manufacturer and product, provide the

- named product that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
2. **Manufacturer/Source:** Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
 3. **Products:** Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
 4. **Manufacturers:** Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
 5. **Basis of Design Product:** Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and characteristics based on the product named. Comply with requirements for consideration of an unnamed product by one of the named manufacturers.
- C. **Visual Matching Specification:** Where Specifications require “*match Architect's sample*”, provide a product that complies with requirements and matches Architect's sample. Architect's decision will be final on whether a proposed product matches.
1. If no product available within specified category matches and complies with specified requirements, comply with requirements of Section 01 25 00 Substitution Procedures for proposal of product.
- D. **Visual Selection Specification:** Where Specifications include the phrase *selected by Architect* or similar phrase, select a product that complies with requirements. Architect will select color, gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

2.3 COMPARABLE PRODUCTS

- A. **Conditions for Consideration:** Architect will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Architect may return requests without action, except to record noncompliance with these requirements:
1. Evidence that the proposed product does not require revisions to the Contract Documents, that it is consistent with the Contract Documents, will produce the indicated results, and that it is compatible with other portions of the Work.
 2. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
 3. Evidence that proposed product provides specified warranty.
 4. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners, if requested.
 5. Samples, if requested.

PART 3 EXECUTION (NOT USED)

SUBSTITUTION REQUEST FORM

Substitution Request Number: _____

To: _____

Project Name/Number: _____

Item Specified:

Section	Page	Paragraph	Description
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The undersigned requests consideration of the following:

Proposed Substitution (Manufacturer, Model # or Name, Color, Etc.): _____

History: ___ New Product, ___ Available 2-5 Years, ___ Available 6-10 Years, ___ Available 10+ Years

Provide UL, ITS, WHI, (or other) listing / rating of proposed substitution: _____

Attached data shall include, but not be limited to, product, specification, drawings, performance and test data adequate for evaluation of the request for the proposed substitution product and the specified product, with applicable portions of the proposed substitution and the specified product data clearly identified in a point-by-point direct comparison chart. Incomplete form and attachments will result in rejection of substitution request.

Requestor shall address the following items on this Substitution Request Form. Use a separate attached sheet attached as needed:

1. Reason for not providing specified item: _____

2. Will proposed substitution affect dimensions indicated on Drawings? ___(Yes) ___(No)

If yes, how? _____

3. Will proposed substitution affect Electrical, Mechanical, Structural, Architectural, etc.?

___(Yes) ___(No) If yes, explain: _____

4. Is proposed substitution larger or smaller than specified product? ___(Yes) ___(No) If yes, state size of substitute product: _____

5. Does proposed substitution weight less/more than specified product? ___(Yes) ___(No) If yes, state weight of substitute product: _____

6. Will proposed substitution affect other trades and/or parts of the Work? ____ (Yes) ____ (No) If yes, explain all effects: _____

7. Comparison between proposed substitution and specified product (Similarities / Differences)?

8. If Substitution Request is accepted, County will receive a credit of \$ _____. The Contract Sum will be adjusted accordingly.
9. Will proposed substitution affect the Contract Time? ____ (Yes) ____ (No) If yes, ____ (Add) ____ (Deduct) _____ calendar days.

INITIAL

UNDERSIGNED CERTIFIES:

- _____ Proposed substitution has been fully investigated and determined to be equal or superior in all respects to specified product.
- _____ Proposed substitution has same or better warranty as specified product.
- _____ Proposed substitution has same or better maintenance service and availability of replacement parts as specified product.
- _____ Proposed substitution will not affect or delay the Construction Schedule.
- _____ Claims for additional costs related to accepted substitution, which may subsequently become apparent, are hereby waived.
- _____ Proposed substitution will not affect dimensions and functional clearances.
- _____ Coordination, installation, and changes in the Work as necessary for installation of accepted substitution will be complete in all respects, at no additional cost to County.
- _____ Contractor will pay for all costs associated with changes to the project's design, including, but not limited to, architectural or engineering design fees, detailing, Agency approvals and construction costs caused by the requested substitution.
- _____ The function, appearance and quality of the proposed substitution is equivalent or superior to the specified item.

The undersigned certifies that the above is accurate and correct:

Signature: _____

Printed Name: _____

Company: _____

Address: _____

Date: _____

Telephone: _____

Attachments: ___ Drawings ___ Product Data ___ Samples ___ Tests ___ Reports ___ Other (Describe)

Architect's Review and Action:

_____ Substitution Accepted – Make submittals in accordance with Specification Section 01 33 00.

_____ Substitution Accepted as Noted - Make submittals in accordance with Spec Section 01 33 00.

_____ Substitution Rejected – Provide specified product.

_____ Substitution Request Received Too Late – Provide specified product.

By: _____ Date: _____

Remarks: _____

END OF SECTION

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements governing execution of the Work including, but not limited to, the following:
 - 1. Construction layout.
 - 2. Field engineering and surveying.
 - 3. Installation of the Work.
 - 4. Coordination of Owner-installed products.
 - 5. Progress cleaning.
 - 6. Starting and adjusting.
 - 7. Protection of installed construction.

1.2 DEFINITIONS

- A. Cutting: Removal of in-place construction necessary to permit installation or performance of other Work.
- B. Patching: Fitting and repair work required to restore construction to original conditions after installation of other work.

1.3 SUBMITTALS

- A. Certificates: Submit certificate signed by land surveyor or professional engineer certifying that location and elevation of improvements comply with requirements.
- B. Landfill Receipts: Submit copy of receipts issued by a landfill facility, licensed to accept hazardous materials, for hazardous waste disposal.
- C. Certified Surveys: Submit two copies signed by land surveyor.
- D. Final Property Survey: Submit 10 copies showing the Work performed and record survey data.

1.4 QUALITY ASSURANCE

- A. Land Surveyor Qualifications: A professional land surveyor legally qualified to practice in the State of California, who is experienced in providing land surveying services of the kind indicated.
- B. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of products and equipment.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Comply with requirements specified in other Sections.
- B. In Place Materials: Use materials for patching identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible:

1. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to Architect for the visual and functional performance of in-place materials.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not warranted. Before beginning site Work, investigate and verify existence and location of underground utilities, mechanical and electrical systems, and construction affecting the Work:
 1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, and water service piping; underground electrical services, and other utilities.
 2. Furnish location data for Work related to the Work that must be performed by public utilities serving the site.
- B. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations:
 1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
 2. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
 3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
- C. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:
 1. Description of the Work.
 2. List of detrimental conditions, including substrates.
 3. List of unacceptable installation tolerances.
 4. Recommended corrections.
- D. Proceed with installation after correcting unsatisfactory conditions. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Existing Utility Information: Furnish information to Owner necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.
- B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.
- D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents caused by differing field conditions outside the

control of Contractor, submit a request for information to Architect according to requirements in Section 01 31 00 Project Management and Coordination.

3.3 CONSTRUCTION LAYOUT

- A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks. If discrepancies are discovered, notify Architect promptly.
- B. Engage a land surveyor or professional engineer to lay out the Work using accepted surveying practices:
 - 1. Establish benchmarks and control points to set lines and levels at each story of construction and elsewhere as necessary to locate each element of Project.
 - 2. Establish limits on use of site.
 - 3. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
 - 4. Inform installers of lines and levels to which they must comply.
 - 5. Check the location, level and plumb, of every major element as the Work progresses.
 - 6. Notify Architect when deviations from required lines and levels exceed allowable tolerances.
 - 7. Close site surveys with an error of closure equal to or less than the standard established by authorities having jurisdiction.
- C. Site Improvements: Locate and lay out site improvements, including pavements, grading, fill and topsoil placement, utility slopes, and rim and invert elevations.
- D. Building Lines and Levels: Locate and lay out control lines and levels for structures, building foundations, column grids, and floor levels, including those required for mechanical and electrical Work. Transfer survey markings and elevations for use with control lines and levels. Level foundations and piers from two or more locations.
- E. Record Log: Maintain a log of layout control Work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by Architect.

3.4 FIELD ENGINEERING

- A. Identification: Owner will identify existing benchmarks, control points, and property corners.
- B. Reference Points: Locate existing permanent benchmarks, control points, and similar reference points before beginning the Work. Preserve and protect permanent benchmarks and control points during construction operations:
 - 1. Do not change or relocate existing benchmarks or control points without prior written approval of Architect. Report lost or destroyed permanent benchmarks or control points promptly. Report the need to relocate permanent benchmarks or control points to Architect before proceeding.
 - 2. Replace lost or destroyed permanent benchmarks and control points promptly. Base replacements on the original survey control points.
- C. Benchmarks: Establish and maintain a minimum of two permanent benchmarks on site, referenced to data established by survey control points. Comply with authorities having jurisdiction for type and size of benchmark:
 - 1. Record benchmark locations, with horizontal and vertical data, on Project Record Documents.

2. Where the actual location or elevation of layout points cannot be marked, provide temporary reference points sufficient to locate the Work.
 3. Remove temporary reference points when no longer needed. Restore marked construction to its original condition.
- D. Certified Survey: On completion of foundation walls, major site improvements, and other Work requiring field-engineering services, prepare a certified survey showing dimensions, locations, angles, and elevations of construction and site work.
- E. Final Property Survey: Engage a land surveyor or professional engineer to prepare a final property survey showing significant features (real property) for Project. Include on the survey a certification, signed by land surveyor or professional engineer, that principal metes, bounds, lines, and levels of Project are accurately positioned as shown on the survey:
1. Show boundary lines, monuments, streets, site improvements and utilities, existing improvements and significant vegetation, adjoining properties, acreage, grade contours, and the distance and bearing from a site corner to a legal point.
 2. Recording: At Substantial Completion, have the final property survey recorded by or with authorities having jurisdiction as the official "property survey."

3.5 INSTALLATION

- A. Locate the work and components of the work accurately, in correct alignment and elevation, as indicated:
1. Make vertical work plumb and make horizontal Work level.
 2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
 3. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.
 4. Maintain minimum headroom clearance of 96 inches (2440 mm) in occupied spaces and 90 inches (2300 mm) in unoccupied spaces.
- B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
- C. Install products at the time and under conditions ensuring the best possible results. Maintain conditions required for product performance until Substantial Completion.
- D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.
- E. Sequence the Work and allow adequate clearances to accommodate movement of construction items on site and placement in permanent locations.
- F. Tools and Equipment: Do not use tools or equipment that produce harmful noise levels.
- G. Templates: Obtain and distribute to the parties involved templates for Work specified to be factory prepared and field installed. Check Shop Drawings of other Work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.
- H. Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions:
1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Architect.

2. Allow for building movement, including thermal expansion and contraction.
 3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- I. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.
 - J. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous. Materials containing asbestos and BCPs are prohibited.

3.6 OWNER INSTALLED PRODUCTS

- A. Site Access: Provide access to site for Owner's construction personnel.
- B. Coordination:
 1. Coordinate construction and operations of the Work with Work performed by Owner's construction personnel:
 - a. Construction Schedule: Inform Owner of Contractor's preferred construction schedule for Owner's portion of the Work. Adjust construction schedule based on a mutually agreeable timetable. Notify Owner if changes to schedule are required due to differences in actual construction progress.
 - b. Pre-installation Conferences: Include Owner's construction personnel at pre-installation conferences covering portions of the Work that are to receive Owner's Work. Attend pre-installation conferences conducted by Owner's construction personnel if portions of the Work depend on Owner's construction.

3.7 PROGRESS CLEANING

- A. Clean site and Work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully:
 1. Comply with requirements in NFPA 241, Standard for Safeguarding Construction, Alteration, and Demolition Operations, for removal of combustible waste materials and debris.
 2. Do not hold waste materials more than seven days during normal weather or three days if the temperature is expected to rise above 80 degrees F (27 degrees C).
 3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.
 4. Use containers intended for holding waste materials of type to be stored.
 5. Coordinate progress cleaning for joint-use areas where Contractor and other contractors are working concurrently.
- B. Site: Maintain site free of waste materials and debris.
- C. Work Areas: Clean areas where Work is in progress to the level of cleanliness necessary for proper execution of the Work:
 1. Remove liquid spills promptly.
 2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.
- D. Installed Work: Keep installed Work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning

materials that are not hazardous to health or property and that will not damage exposed surfaces.

- E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.
- F. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.
- G. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways. Comply with waste disposal requirements in Section 01 50 00.
- H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.
- I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.
- J. Limiting Exposures: Supervise construction operations to assure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

3.8 STARTING AND ADJUSTING

- A. Coordinate startup and adjusting of equipment and operating components with mechanical, plumbing, and electrical requirements.
- B. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.
- C. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.
- D. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- E. Manufacturer's Field Service: Comply with qualification requirements in Section 01 40 00.

3.9 PROTECTION OF INSTALLED CONSTRUCTION

- A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.
- B. Comply with manufacturer's written instructions for temperature and relative humidity.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Contractor shall be responsible for cutting, fitting and patching required to complete Work and to:
 - 1. Make its parts fit together properly.
 - 2. Uncover work to provide for installation of ill-timed work.
 - 3. Remove and replace defective work.
 - 4. Remove and replace work not conforming to Contract Documents.
 - 5. Remove samples of installed work as required for testing.
 - 6. Provide routine penetrations of non-structural surfaces for installation of piping and electrical conduit.

1.2 REQUESTS FOR INFORMATION

- A. Submit a written request to Architect well in advance of executing cutting or alteration which affects:
 - 1. Work of Owner or separate contractor.
 - 2. Structural value or integrity of any element of Project.
 - 3. Integrity of weather-exposed or moisture-resistant elements.
 - 4. Efficiency, operational life, maintenance or safety of operational elements.
 - 5. Visual qualities of sight-exposed elements.
- B. Requests shall include:
 - 1. Identification of Project and description of affected work.
 - 2. Necessity for cutting or alteration.
 - 3. Effect on work of Owner or separate contractor.
 - 4. Effect on structural integrity, or weatherproof integrity of Project.
 - 5. Alternatives to cutting and patching.
 - 6. Cost proposal, when applicable.
 - 7. Written permission of separate contractor whose work will be affected.
 - 8. Description of proposed work including:
 - a. Scope of cutting, patching, alteration, or excavation.
 - b. Products proposed to be used.
 - c. Extent of refinishing to be included.

- C. Should conditions of Work or schedule indicate a change of products from original installation, Contractor shall submit request for substitution as specified in Section 01 62 00 - Product Options.
- D. Submit written notice to Architect designating date and time that work will be uncovered.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Comply with Specifications and standards for each specific product involved.
- B. Where Specifications and standards have not been provided, provide materials and fabrication consistent with quality of Project and intended for commercial construction.
- C. Provide new materials for cutting and patching unless otherwise indicated.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Inspect existing conditions of Project, including elements subject to damage or to movement during cutting and patching.
- B. After uncovering work, inspect conditions affecting installation of products, or performance of work.
- C. Report unsatisfactory or questionable conditions to Architect in writing; do not proceed with work until Architect has provided further instructions.

3.2 PREPARATION

- A. Provide adequate temporary support as necessary to assure structural value or integrity of affected portion of Work.
 - 1. Provide services of licensed engineer for designing temporary support where required by applicable authorities for temporary supports and for shoring; submit engineering calculations directly to applicable authorities upon request.
- B. Protect other portions of Project from damage.

3.3 PERFORMANCE

- A. Execute cutting by methods that provide proper surfaces to receive installation of repairs and finishes.
 - 1. Execute excavating and backfilling by methods which will prevent settlement and which will prevent damage to other work.
- B. Employ same installer or fabricator to perform cutting and patching work as employed for new construction for:
 - 1. Weather-exposed or moisture resistant elements.
 - 2. Sight-exposed finished surfaces.

- C. Execute fitting and adjustment of products to provide a finished installation to comply with specified products, functions, tolerances and finishes.
- D. Restore work that has been cut or removed; install new products to provide completed Work in accordance with requirements of Contract Documents.
- E. Fit work tight to pipes, sleeves, ducts, conduit and penetrations through surfaces.
- F. Refinish entire surfaces as necessary to provide even finish to match adjacent finishes:
 - 1. For continuous surfaces, refinish to nearest intersection.
 - 2. For an assembly, refinish entire unit.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes administrative and procedural requirements for the following:
 - 1. Salvaging nonhazardous demolition and construction waste.
 - 2. Recycling nonhazardous demolition and construction waste.
 - 3. Disposing of nonhazardous demolition and construction waste.

1.2 DEFINITIONS

- A. Construction Waste: Building and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging. Alternative Daily Cover (ADC) does not qualify as material diverted from disposal. Land-clearing debris is not considered construction, demolition, or renovation waste that can contribute to waste diversion.
- B. Demolition Waste: Building and site improvement materials resulting from demolition or selective demolition operations.
- C. Disposal: Removal off-site of demolition and construction waste and subsequent sale, recycling, reuse, or deposit in landfill or incinerator acceptable to authorities having jurisdiction.
- D. Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.
- E. Salvage: Recovery of demolition or construction waste and subsequent sale or reuse in another facility.
- F. Salvage and Reuse: Recovery of demolition or construction waste and subsequent incorporation into the Work.

1.3 PERFORMANCE REQUIREMENTS

- A. General: Develop and implement a construction and demolition waste management plan that results in end-of-Project rates for salvage/recycling of at least 75 percent by weight of total waste generated by the Work.

1.4 SUBMITTALS

- A. Waste Management Plan: Submit 3 copies of plan within 14 days of date established for the Notice to Proceed.
- B. Waste Reduction Progress Reports: Concurrent with each Application for Payment, submit three copies of report. Include separate reports for demolition and construction waste. Include the following information:
 - 1. Material category.
 - 2. Generation point of waste.

3. Total quantity of waste in tons.
 4. Quantity of waste salvaged, both estimated and actual in tons.
 5. Quantity of waste recycled, both estimated and actual in tons.
 6. Total quantity of waste recovered (salvaged plus recycled) in tons.
 7. Total quantity of waste recovered (salvaged plus recycled) as a percentage of total waste.
- C. Waste Reduction Calculations: Before request for Substantial Completion, submit three copies of calculated end-of-Project rates for salvage, recycling, and disposal as a percentage of total waste generated by the Work.
- D. Records of Donations: Indicate receipt and acceptance of salvageable waste donated to individuals and organizations. Indicate whether organization is tax exempt.
- E. Records of Sales: Indicate receipt and acceptance of salvageable waste sold to individuals and organizations. Indicate whether organization is tax exempt.
- F. Recycling and Processing Facility Records: Indicate receipt and acceptance of recyclable waste by recycling and processing facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.
- G. Landfill and Incinerator Disposal Records: Indicate receipt and acceptance of waste by landfills and incinerator facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.
- H. Qualification Data: For Waste Management Coordinator.
- I. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.

1.5 QUALITY ASSURANCE

- A. Waste Management Coordinator Qualifications: Minimum 2 years construction experience.
- B. Refrigerant Recovery Technician Qualifications: Certified by EPA-approved certification program.
- C. Waste Management Conference: Conduct conference at Project site.

1.6 WASTE MANAGEMENT PLAN

- A. General: Develop plan consisting of waste identification and waste reduction work plan. Include separate sections in plan for demolition and construction waste. Indicate quantities by weight or volume, but use same units of measure throughout waste management plan.
- B. Waste Identification: Indicate anticipated types and quantities of demolition site-clearing and construction waste generated by the Work. Include estimated quantities and assumptions for estimates. Identify at least five materials (both structural and nonstructural) targeted for diversion.

- C. Waste Reduction Work Plan: List each type of waste and whether it will be salvaged, recycled, or disposed of in landfill or incinerator. Include points of waste generation, total quantity of each type of waste, quantity for each means of recovery, and handling and transportation procedures. Specify whether materials will be separated or comingled.
1. Salvaged Materials for Reuse: For materials that will be salvaged and reused in this Project, describe methods for preparing salvaged materials before incorporation into the Work.
 2. Salvaged Materials for Sale: For materials that will be sold to individuals and organizations, include list of their names, addresses, and telephone numbers.
 3. Salvaged Materials for Donation: For materials that will be donated to individuals and organizations, include list of their names, addresses, and telephone numbers.
 4. Recycled Materials: Include list of local receivers and processors and type of recycled materials each will accept. Include names, addresses, and telephone numbers.
 5. Disposed Materials: Indicate how and where materials will be disposed of. Include name, address, and telephone number of each landfill and incinerator facility.
 6. Handling and Transportation Procedures: Include method that will be used for separating recyclable waste including sizes of containers, container labeling, and designated location on Project site where materials separation will be located.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 PLAN IMPLEMENTATION

- A. General: Implement waste management plan as approved by Architect. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.
- B. Waste Management Coordinator: Engage a waste management coordinator to be responsible for implementing, monitoring, and reporting status of waste management work plan. Coordinator shall be present at Project site full time for duration of Project.
- C. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work occurring at Project site.
1. Distribute waste management plan to everyone concerned within three days of submittal return.
 2. Distribute waste management plan to entities when they first begin work on-site. Review plan procedures and locations established for salvage, recycling, and disposal.
- D. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
1. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged, recycled, reused, donated, and sold.
 2. Comply with Division 01 Section "Temporary Facilities and Controls" for controlling dust and dirt, environmental protection, and noise control.

3.2 SALVAGING DEMOLITION WASTE

- A. Salvaged Items for Reuse in the Work:
 - 1. Clean salvaged items.
 - 2. Pack or crate items after cleaning. Identify contents of containers.
 - 3. Store items in a secure area until installation.
 - 4. Protect items from damage during transport and storage.
 - 5. Install salvaged items to comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make items functional for use indicated.
- B. Salvaged Items for Sale and Donation: Not permitted on Project site.
- C. Salvaged Items for Owner's Use:
 - 1. Clean salvaged items.
 - 2. Pack or crate items after cleaning. Identify contents of containers.
 - 3. Store items in a secure area until delivery to Owner.
 - 4. Transport items to Owner's storage area on-site.
 - 5. Protect items from damage during transport and storage.

3.3 RECYCLING DEMOLITION AND CONSTRUCTION WASTE, GENERAL

- A. General: Recycle paper and beverage containers used by on-site workers.
- B. Recycling waste materials shall accrue to Contractor.
- C. Procedures: Separate recyclable waste from other waste materials, trash, and debris. Separate recyclable waste by type at Project site to the maximum extent practical.
 - 1. Provide appropriately marked containers or bins for controlling recyclable waste until they are removed from Project site. Include list of acceptable and unacceptable materials at each container and bin.
 - a. Inspect containers and bins for contamination and remove contaminated materials if found.
 - 2. Stockpile processed materials on-site without intermixing with other materials. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
 - 3. Stockpile materials away from construction area. Do not store within drip line of remaining trees.
 - 4. Store components off the ground and protect from the weather.
 - 5. Remove recyclable waste off Owner's property and transport to recycling receiver or processor.

3.4 RECYCLING DEMOLITION WASTE

- A. Asphaltic Concrete Paving: Grind asphalt to maximum 1-1/2-inch size, or as required by recycling facility.
- B. Asphaltic Concrete Paving: Break up and transport paving to asphalt-recycling facility.

- C. Concrete: Remove reinforcement and other metals from concrete and sort with other metals.
 - 1. Pulverize concrete to maximum 1-1/2-inch size, or as required by recycling facility.
- D. Masonry: Remove metal reinforcement, anchors, and ties from masonry and sort with other metals.
 - 1. Pulverize masonry to maximum 1-1/2-inch size, or as required by recycling facility.
 - 2. Clean and stack undamaged, whole masonry units on wood pallets.
- E. Wood Materials: Sort and stack members according to size, type, and length. Separate lumber, engineered wood products, panel products, and treated wood materials.
- F. Metals: Separate metals by type.
 - 1. Structural Steel: Stack members according to size, type of member, and length.
 - 2. Remove and dispose of bolts, nuts, washers, and other rough hardware.
- G. Asphalt Shingle Roofing: Separate organic and glass-fiber asphalt shingles and felts. Remove and dispose of nails, staples, and accessories.
- H. Gypsum Board: Stack large clean pieces on wood pallets and store in a dry location. Remove edge trim and sort with other metals. Remove and dispose of fasteners.
- I. Acoustical Ceiling Panels and Tile: Stack large clean pieces on wood pallets and store in a dry location.
 - 1. Separate suspension system, trim, and other metals from panels and tile and sort with other metals.
- J. Carpet and Pad: Roll large pieces tightly after removing debris, trash, adhesive, and tack strips.
 - 1. Store clean, dry carpet and pad in a closed container or trailer provided by Carpet Reclamation Agency or carpet recycler.
- K. Equipment: Drain tanks, piping, and fixtures. Seal openings with caps or plugs. Protect equipment from exposure to weather.
- L. Plumbing Fixtures: Separate by type and size.
- M. Piping: Reduce piping to straight lengths and store by type and size. Separate supports, hangers, valves, sprinklers, and other components by type and size.
- N. Lighting Fixtures: Separate lamps by type and protect from breakage.
- O. Electrical Devices: Separate switches, receptacles, switchgear, transformers, meters, panel boards, circuit breakers, and other devices by type.
- P. Conduit: Reduce conduit to straight lengths and store by type and size.

3.5 RECYCLING CONSTRUCTION WASTE

- A. Packaging:

1. Cardboard and Boxes: Break down packaging into flat sheets. Bundle and store in a dry location.
 2. Polystyrene Packaging: Separate and bag materials.
 3. Pallets: As much as possible, require deliveries using pallets to remove pallets from Project site. For pallets that remain on-site, break down pallets into component wood pieces and comply with requirements for recycling wood.
 4. Crates: Break down crates into component wood pieces and comply with requirements for recycling wood.
- B. Site-Clearing Wastes: Chip brush, branches, and trees on-site at location indicated by owner.
- C. Wood Materials:
1. Clean Cut-Offs of Lumber: Grind or chip into small pieces.
 2. Clean Sawdust: Bag sawdust that does not contain painted or treated wood.
- D. Gypsum Board: Stack large clean pieces on wood pallets and store in a dry location.
1. Clean Gypsum Board: Grind scraps of clean gypsum board using small mobile chipper or hammer mill. Screen out paper after grinding.

3.6 DISPOSAL OF WASTE

- A. General: Except for items or materials to be salvaged, recycled, or otherwise reused, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.
1. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
- B. Burning: Do not burn waste materials.
- C. Burning: Burning of waste materials is permitted only at designated areas on Owner's property, provided required permits are obtained. Provide full-time monitoring for burning materials until fires are extinguished.
- D. Disposal: Transport waste materials and dispose of at designated spoil areas on Owner's property.
- E. Disposal: Transport waste materials off Owner's property and legally dispose of them.

END OF SECTION

PART 1 GENERAL

1.1 PRE-CLOSEOUT MEETING

- A. Pre-Closeout Meeting: Schedule and convene Pre-Closeout Meeting with Owner and Architect in accordance with Section 01 31 00, "Project Management and Coordination."

1.2 SUBSTANTIAL COMPLETION

- A. The items listed in the Supplementary Conditions and the following items shall be completed before Substantial Completion will be granted:
1. Contractor's Completion List (Punch List): Submit a thorough list of items to be completed or corrected, along with a written request for Substantial Completion and for review of the Work or portion of the Work. The Architect/Engineer's Project Representative, at their discretion, may attend and assist in the preparation of the Contractor's Punch List.
 2. Architect's Supplemental Punch List: The Architect/Engineer, along with the Owner at the Owner's discretion, will inspect the Work utilizing the Contractor's prepared Punch List, noting completed items and incomplete items, and will prepare a supplemental list of items that have been omitted or incomplete items that were not previously noted.
 3. Operations and Maintenance Manuals: Submit as described in paragraph 1.4.
 4. Final Cleaning: Provide final cleaning and adequate protection of installed construction as described in paragraph 1.7 and 1.8.
 5. Starting of systems: Start up equipment and systems as described in paragraph 1.9.
 6. Testing and balancing: Testing and balancing of systems must be performed and completed, and the report submitted and accepted by Architect/Engineer and Owner, as described in the Contract Documents. Make adjustments to equipment as required to achieve acceptance.
 7. Demonstrations: If required by individual specification sections or by Owner, provide demonstrations and instructions for use of equipment as described in paragraph 1.10.
- B. Date of Substantial Completion: Complete or correct items identified on Punch List and confirm that all items have been corrected prior to Architects re-inspection. Architect/Engineer, along with the Owner, will re-inspect the corrected work to establish the Date of Substantial Completion. Incomplete items remaining will be appended to the Certificate of Substantial Completion. The Date of Substantial Completion represents day one (1) of the closeout period, and represents the date of commencement of the Contractors correctional period and all warranty periods as described and required by the Contract Documents, except as amended in the Certificate of

Substantial Completion and elsewhere in the Contract Documents.

- C. Certificate of Substantial Completion: When the Work or designated portion thereof is substantially complete, Architect will prepare the Certificate of Substantial Completion to be executed by the Owner and Contractor. Items on the appended Punch List shall be completed or corrected within the time limits established in the Certificate.

1.3 PUNCH LIST

- A. A comprehensive list prepared by the Contractor prior to Substantial Completion, and attached thereto, to establish all items to be corrected, or limited items of work to be completed, if any. This list is intended to represent a limited number of items needing attention.
- B. Punch lists shall be furnished to the Architect in Microsoft Excel and PDF formats. The punch list shall be in matrix form and shall include the following information for each punch list item:
 - 1. Room number or other suitable location identifier.
 - 2. Description of the work.
 - 3. Sub-contractor/trade sign-off that the work has been verified to be 100% complete and in accordance with the Contract Documents.
 - 4. Sub-contractor/trade sign-off date.
 - 5. General contractor sign-off that the work has been verified to be 100% complete and in accordance with the Contract Documents.
 - 6. General contractor/trade sign-off date.
 - 7. A/E consultant sign-off.
 - 8. A/E consultant sign-off date.
 - 9. If requested by the Owner, provide two additional similar columns for their sign-off.
 - 10. In the case of excessive repetition of the same item at various locations, the punch list may contain "general notes/items" that shall be applied to the entire project; and it shall be the responsibility of the contractor/sub-contractor to thoroughly examine the entire project and make corrective measures at all applicable locations.
- C. Should the Architect determine that the Contractor's punch list lacks sufficient detail or requires extensive supplementation, the punch list will be returned to the Contractor for re-inspection and revision. The date of Substantial Completion will be delayed until the punch list submitted is a reasonable representation of the work to be done.
- D. A significantly large number of items to be completed or corrected will preclude the Architect from issuing a Certificate of Substantial Completion. The Owner and Architect will be the sole judge of what constitutes a significantly large number of items. It is anticipated that the detailed list of items of work to be completed or corrected at the Date of Substantial

Completion shall be no longer than five (5) typed pages.

- E. The Contractor's superintendent shall participate in the preparation of the Contractor's punch list that is submitted to the Architect and Owner for supplementation. Upon receipt, the Architect and Consultants shall perform a spot review to determine the adequacy and completeness of the Contractor's punch list.
- F. Upon receipt of an acceptable Contractor's punch list, the Contractor's Superintendent shall accompany the Architect, his Consultants and the Owner (at his discretion) during their observation and the preparation of their supplements to the Contractor's punch list.
 - 1. The Superintendent shall record or otherwise take note of all supplementary items.
 - 2. The Architect will endeavor to furnish to the Contractor typed, hand written or recorded supplements to the punch list in a prompt manner; however, any delay in the Contractor's receiving said supplements from the Architect will not be cause for a claim for additional cost or extension of time as the Contractor's Superintendent shall have been in attendance during the inspections of the Architect and his Consultants and will have been expected to take his own notes.

1.4 OPERATIONS AND MAINTENANCE MANUAL

- A. As a requirement for Substantial Completion, the final Operation and Maintenance Manual shall be submitted to, and reviewed and accepted by the Architect prior to issuance of the Certificate.
- B. Prepare 3-ring D-slant binder cover and spline with printed title "OPERATIONS AND MAINTENANCE MANUAL", title of project, and subject matter of binder when multiple binders are required. The same shall also be provided in .pdf format on a usb drive.
- C. Submit one (1) copy of preliminary Operations and Maintenance Manuals to respective consultants (Civil, MEP, Structural, *etc.*) for review of conformance with contract requirements prior to submitting final to Architect. Allow time for proper review.
- D. Internally subdivide binder contents with permanent page dividers, logically organized as described below; with tab titling clearly printed under reinforced laminated plastic tabs.
- E. Drawings: Provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.
- F. Contents: Prepare Table of Contents for each volume, with each product or system description identified, typed on white paper, in three parts as follows:
 - 1. Part 1: Directory, listing names, addresses, and telephone numbers of

Architect/Engineer, Contractor, Subcontractors, and major equipment suppliers.

2. Part 2: Operation and Maintenance, arranged by system and subdivided by specification section. For each category, identify names, addresses, and telephone numbers of Subcontractors and suppliers. Identify the following:
 - a. Significant design criteria.
 - b. List of equipment.
 - c. Parts list for each component.
 - d. Equipment start-up instructions
 - e. Operating instructions.
 - f. Maintenance instructions for equipment and systems.
 - g. Maintenance instructions for finishes, including recommended cleaning methods and materials, and special precautions identifying detrimental agents.
 3. Part 3: Project documents and certificates, including the following:
 - a. Product data.
 - b. Air and water balance reports.
 - c. Photocopies of warranties, certificates and bonds. Submit originals with Closeout Documents as specified below.
- G. Submit one (1) final original and two (2) copies to Architect.
- H. Contractor shall provide a usb drive, or other form of digital media acceptable to the Owner, with files in PDF Format, the following documents after approval by the Architect, Consultants and Owner: closeout manual, MSDS binder, O&M Manuals, specifications and approved submittals. Documents shall be hyper-linked to the Table of Contents.

1.5 PROJECT CLOSEOUT

- A. Final Payment will not be authorized by the Architect until the Architect finds the Work acceptable under the Contract Documents, subject to the completion and acceptance of the following requirements and other applicable Contract requirements:
1. Close-out Documents: Provide bound closeout documents.
 2. As-Built and Record Documents.
 3. Extra materials: Provide extra stock, materials, and products.
 4. Locks: Make final changeover of permanent locks and transmit keys to the Owner. Advise the Owner's personnel of changeover in security provisions.
 5. Temporary Facilities: Discontinue and remove temporary facilities from the site, along with mockups, construction aids, and similar elements.
 6. Warranties, Certificates and Bonds: Execute and assemble transferable warranty documents, certificates, and bonds from subcontractors, suppliers, and manufacturers.
 7. Final Inspection and Acceptance by Owner's Representative.

1.6 CLOSEOUT DOCUMENTS

- A. Coordinate the following items with the requirements of the General

Conditions and, Supplementary General Conditions of the Contract.

- B. Prepare 3-ring D-slant binder cover and spline with printed title "CLOSEOUT DOCUMENTS", title of project, and subject matter of binder when multiple binders are required. Submit one (1) original and two (2) copies.
- C. Internally subdivide binder contents with permanent page dividers, logically organized as described below; with tab titling clearly printed under reinforced laminated plastic tabs.
- D. The close-out documents shall be neatly organized and easily useable as determined by the Architect and Owner. Separate Close-out Documents binders from Operations and Maintenance Manuals. Documents identified as "affidavit" shall be notarized.
- E. Contents: Prepare Table of Contents for each volume, with each item description identified, typed on white paper, in five (5) parts as follows:
 - 1. Part 1: Directory, listing names, addresses, and telephone numbers of Architect/Engineer, Contractor, Subcontractors, and major equipment suppliers. All General Contractor's vendors/suppliers and subcontractors that provided materials or performed any work related to this project must be listed on this form. Submit Final List of Subcontractors.
 - 2. Part 2: Closeout Documents and Affidavits, include the following:
 - a. Consent of Surety to Final Payment;
 - b. Contractor's Affidavit of Payment of Debts and Claims;
 - c. Contractor's Affidavit of Release of Liens;
 - 3. Part 3: Project documents and certificates, including the following:
 - a. Copy of Certificate of Substantial Completion (AIA G704);
 - b. Copy of All Permits;
 - c. Copy of Final Utility Bill or letter of transfer;
 - d. Copy of Certificate of Occupancy;
 - e. Copy of Certification of Project Compliance: Owner and Architect will initiate form and forward to Contractor for signature once Substantial Completion is established. (Owner to be provided original separately);
 - 4. Part 4: Warranties, Release of Liens, compile sequentially based on specification sections:
 - a. General Contractor's Warranty: Submit on company letterhead as described below. This Warranty shall state all sections of Work performed by General Contractor's own forces, and warranty period for each section of Work;
 - b. Subcontractor's Release of Lien: Include contractors, subcontractor's and direct material and equipment supplier's separate final releases.
 - c. Hazardous Material Certificate: Affidavits from Contractor, Subcontractors and General Contractor's vendors or suppliers stating that no hazardous materials/products have been used or installed in this project.
 - d. Subcontractor's Warranty: notarized, and submitted. This Warranty shall state all sections of Work performed by the subcontractor and warranty period.
 - e. Special / Extended Warranties; List and provide, notarized warranties requested by Owner, or required by or incorporated in the Contract Documents.
 - f. Spreadsheet depicting all items and materials that carry a warranty longer than one (1) year. Include information consisting of material/ supplier/ installer/ specification

section/ length of warranty and contact information.

5. Part 5: Receipts:
 - a. Extra Stock: Provide original receipts for delivery of "Extra Stock" items as described below. Receipts must be signed by an authorized Owner's representative;
 - b. Keys: Provide original receipts for delivery of "Keys". Receipts must be signed by an authorized Owner's representative.
 - c. Sign in sheets: provide signatures of attendees from all demonstrations.

- F. In addition to the three (3) required close-out binders listed above, provide Architect with one (1) separate binder for their records containing the following:
 1. Directory, listing names, addresses, and telephone numbers of Architect/Engineer, Contractor, Subcontractors, and major equipment suppliers;
 2. All MSDS sheets for the project;
 3. All warranties from Contractor, subcontractors, direct suppliers, and manufacturers.

- G. Failure to complete and close-out project after substantial completion may result in liquidated damages being assessed to the Contractor. Refer to Conditions of the Contract for additional requirements and liquidated damages.

1.7 FINAL CLEANING

- A. Execute final cleaning prior to final project inspection and acceptance.
- B. Clean interior and exterior glass, and surfaces exposed to view; remove temporary labels, stains and foreign substances, polish transparent and glossy surfaces, vacuum carpeted and soft surfaces, mop hard floor surfaces.
- C. Remove smudges, marks, stains, fingerprints, soil, dirt, spots, dust, lint, and other foreign materials from finished and exposed surfaces
- D. Clean equipment and fixtures to sanitary condition with cleaning materials appropriate to surface and material being cleaned.
- E. Clean and replace filters of operating equipment as required by Contract Documents
- F. Clean debris from roofs, gutters, downspouts, and drainage systems.
- G. Clean site; sweep paved areas, rake clean landscaped surfaces.
- H. Remove waste and surplus materials, rubbish, and temporary construction facilities from site.

1.8 PROTECTING INSTALLED CONSTRUCTION

- A. Protect installed Work and provide special protection where specified in individual specification sections until Work is accepted by Architect and Owner.
- B. Provide temporary and removable protection for installed products. Control activity in immediate work area to prevent damage.
- C. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings.
- D. Protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects, by protecting with durable sheet materials.
- E. Prohibit traffic or storage upon waterproofed or roofed surfaces. When traffic or activity is necessary, obtain recommendations for protection from waterproofing or roofing material manufacturer.
- F. Prohibit traffic from landscaped areas.

1.9 STARTING OF SYSTEMS

- A. Coordinate schedule for start-up of various equipment and systems.
- B. Notify Architect/Engineer and Owner 48 hours prior to start-up of each item.
- C. Verify each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, and for conditions which may cause damage.
- D. Verify tests, meter readings, and specified electrical characteristics agree with those required by equipment or system manufacturer.
- E. Verify wiring and support components for equipment are complete and tested.
- F. Execute start-up under supervision of Contractors' personnel, and installer in accordance with manufacturers' instructions.
- G. When specified in individual specification sections or required by manufacturer, require manufacturer to provide authorized representative to be present at site to inspect, check, and approve equipment or system installation prior to start-up, and to supervise placing equipment or system in operation.
- H. When specified in individual specification sections or required by Owner or Architect/Engineer, submit a written report, that equipment or system has been properly installed and is functioning correctly.

1.10 DEMONSTRATION AND INSTRUCTIONS

- A. Demonstrate operation and maintenance of products to Owner's personnel a minimum of 48 hours prior to date of Final Completion in accordance with Owner's requirements.
- B. Demonstrate Project equipment instructed by qualified manufacturer's representative who is knowledgeable about the Project and equipment.
- C. For equipment or systems requiring seasonal operation, perform demonstration for other season within six (6) months.
- D. Utilize maintenance manuals as basis for instruction. Review contents of manual with Owner's personnel to explain all aspects of operation and maintenance.
- E. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment.
- F. Prepare and insert additional data in maintenance manuals when need for additional data becomes apparent during instruction.
- G. Review and verify proper start-up and operation of equipment prior to scheduling demonstrations with Owner.
- H. All demonstrations are to be documented by video and submitted to the Owner in DVD format along with the close out documents. General contractor is responsible for all video and compilation onto DVD with linked menus.

1.11 PROJECT AS-BUILT & RECORD DOCUMENTS

- A. Project As-built Documents, as described in Section 01 78 39, shall be submitted at Project Closeout. Final Payment will not be authorized by the Architect until final review and acceptance by Architect and Engineers is achieved in accordance with the Owners requirements.
- B. As-built Drawings, as described in Section 01 78 39, shall be complete and accurate to the Architect's satisfaction. As-built Drawings shall be sufficient for production and drafting of Record Drawings in CAD format by Architect.
- C. Submit reproducible to respective consultants (Civil, Structural, MEP, etc.) for review. Consultant will mark-up corrections and return to Contractor for final revisions. Make final revisions prior to submitting to Architect.
 - 1. Format: One (1) set of full-sized bound set of full-color prints of marked-up As-built Drawing file..
 - 2. Provide the Owner with one (1) set of As-built Drawings on a USB thumb-drive in marked-up pdf format..

3. Label electronic files and PDF files in the same manner as the sheets (example, A2.02 First Floor Area 'A', etc.) if in separate files, or with bookmarks labelling each sheet and section of the drawings if in one file.

1.12 EXTRA STOCK, MATERIALS AND MAINTENANCE PRODUCTS

- A. Furnish extra stock, maintenance, and extra products in quantities specified in individual specification sections.
- B. Deliver to Project site or to Facility Maintenance Department as directed by Owner; obtain signed receipt from Owner's authorized representative prior to final application for payment. Delivery of materials to, or obtaining receipt from anyone other than Owner's authorized representative may constitute breach of this requirement and may require delivery of additional materials at no cost to the Owner if original materials are misplaced.
- C. Include signed receipts for delivery of extra stock and materials, including keys, with Closeout Documents.

1.13 WARRANTIES, CERTIFICATES AND BONDS

- A. Definitions:
 1. Standard Product Warranties: preprinted written warranties published by individual manufacturers for particular products and are specifically endorsed by the manufacturer to the Owner.
 2. Special Warranties: Written warranties required by or incorporated in the Contract Documents, either to extend time limits provided by standard warranties or to provide coverage of specific defects, or both.
- B. In accordance with the general warranty obligations under Paragraph 3.5 of the General Conditions as amended by the Supplementary Conditions, the General Contractor's warranty shall be for a period of one (1) year following the date of Substantial Completion, hereinafter called the one-year warranty period. The Contractor's one-year general warranty shall include all labor, material and delivery costs required to correct defective material and installation. This warranty shall not limit the Owner's rights with respect to latent defects, gross mistakes, or fraud.
- C. The Contractor's one-year warranty shall run concurrently with the one (1) year period for correction of Work required under Paragraph GC13 of the General Conditions.
- D. No service charges or call out charges are allowed to investigate warranty claims.
- E. In addition to the Contractor's one-year warranty, Special Warranties as described in individual specifications sections, shall extend the warranty period for the period specified without limitation in respect to other

obligations which the Contractor has under the Contract Documents.

- F. Manufacturer's disclaimers and limitations on product warranties do not relieve the Contractor of the warranty on the Work that incorporates the products, nor does it relieve the suppliers, manufacturers, and subcontractors required to countersign special warranties with the Contractor.
- G. Warranty Requirements:
 - 1. When correcting warranted Work that has failed, remove and replace other Work that has been damaged as a result of such failure or that must be removed and replaced to provide access for correction of warranted Work.
 - 2. When Work covered by a warranty has failed and been corrected by replacement or reconstruction, reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.
 - 3. Upon determination that Work covered by a warranty has failed, replace or rebuild the Work to an acceptable condition complying with requirements of Contract Documents. The Contractor is responsible for the cost of replacing defective Work regardless of whether the Owner has benefited from use of the Work through a portion of its anticipated useful service life.
 - 4. Written warranties made to the Owner are in addition to implied warranties, and shall not limit the duties, obligations, rights and remedies otherwise available under the law, nor shall warranty periods be interpreted as limitations on time in which the Owner can enforce such other duties, obligations, rights, or remedies.
 - 5. The Owner reserves the right to refuse to accept Work for the Project where a special warranty, certification, or similar commitment is required on such Work or designated portion of the Work, until evidence is presented that entities required to countersign such commitments are willing to do so.
- H. Compile copies of each required warranty properly executed by the Contractor and the subcontractor, supplier, or manufacturer. Verify documents are in proper form, contain full information, and are notarized. Co-execute warranties, certificates and bonds when required and include signed warrantees with Closeout Documents submitted to the Architect.

1.14 FINAL COMPLETION AND FINAL PAYMENT

- A. Final Notice and Inspection:
 - 1. When all items on the Punch List have been corrected, final cleaning has been completed, and installed work has been protected, submit written notice to the Architect that the Work is ready for final inspection and acceptance.

2. Upon receipt of written notice that the Work is ready for final inspection and acceptance, the Architect and Engineer will make final inspection.
- B. Final Change Order: When the Project Closeout items described above are successfully completed and the Work is found acceptable to Architect/Engineer and Owner, a Final Change Order will be executed. This Change Order will include any Allowance adjustments as required by the Contract Documents.
- C. Final Application for Payment: When all of the above items are successfully complete, submit to the Architect a final Application for Payment and request for release of retainage.
- D. Release of Retainage: Release of retainage will not be authorized by the Architect until Contractor completes all requirements for close-out to the satisfaction of the Owner and Architect as described herein.

1.15 TERMINAL INSPECTION

- A. Immediately prior to expiration of the one (1) year period for correction of the Work, the Contractor shall make an inspection of the work in the company of the Architect and the Owner. The Architect and the Owner shall be given not less than ten (10) days' notice prior to the anticipated date of terminal inspection.
- B. Where any portion of the work has proven to be defective and requires replacement, repair or adjustment, the Contractor shall immediately provide materials and labor necessary to remedy such defective work and shall execute such work without delay until completed to the satisfaction of the Architect and the Owner, even if the date of completion of the corrective work may extend beyond the expiration date of the correction period.
- C. The Contractor shall not be responsible for correction of work which has been damaged because of neglect or abuse by the Owner nor the replacement of parts necessitated by normal wear in use.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes: Administrative and procedural requirements for project as-built documents, including but not limited to:
 - 1. As-built Drawings.
 - 2. As-built Specifications.
 - 3. As-built Product Data.
 - 4. Miscellaneous as-built and record submittals.
- B. Contractor's Responsibility for As-Built documentation:
 - 1. CONTRACTOR shall collect information, produce and maintain a set of as-built drawings and specifications digitally during the course of construction. This set of as-built drawings shall be updated per current work on the project, and verification of updates shall be provided to the Construction Administrator on a monthly basis as a prerequisite to approval of CONTRACTOR's pay application.
 - 2. The digital as-built files may be maintained on a shared cloud storage location for joint use and inspection by the Contractor, Construction Administrator, Owner and Architect throughout the course of work. The digital file may be a .pdf file with all markup as indicated below to be included in the file and added via pdf editing/markup software such as Bluebeam.
 - 3. At the completion of construction, during closeout, the file will be completed by the Contractor and transferred to the Architect. The Architect will review the as-built drawings for completeness and shall provide any comments to the contractor for corrections to be made prior to acceptance.

1.3 CLOSEOUT SUBMITTALS

- A. As-built Drawings:
 - 1. Number of Copies: Submit As-Built Drawings as a digital file in marked-up pdf format and printed hard copy as indicated below.:
 - Initial Submittal:
 - 1) Submit PDF electronic files of marked up as-built prints.
 - 2) Architect will indicate whether general scope of changes, additional information recorded, and quality of drafting are acceptable.
 - Final Submittal:
 - 1) Submit PDF electronic files of revised marked up as-built drawings.
 - 2) Submit one full-sized hard-copy of As-Built Set. Plot each sheet, whether or not changes and additional information were recorded.
- B. As-Built Specifications: Submit one paper copy and one annotated PDF electronic file of the Project Specifications, including addenda and contract modifications.
- C. As-Built Product Data: Submit one paper copy and one annotated PDF electronic file with bookmarked directory of submittals.
 - 1. Where As-Built Product Data are required as part of operation and maintenance manuals, submit duplicate marked up Product Data as a component of manual.

- D. Miscellaneous As-Built Submittals: Refer to the individual Specification Sections for miscellaneous record keeping requirements and submittals in connection with various construction activities. Submit one paper copy and marked-up PDF electronic file with bookmarked directory including each submittal.
- E. Reports: **Submit written report monthly with, or prior to, application for payment** indicating items incorporated into project as-built documents concurrent with progress of the work, including revisions, concealed conditions, field changes, product selections, and other notations incorporated. The As-Built Plans, Specifications and other data shall be current (up-to-date) to qualify for payment and subject to verification by the Construction Administrator. At County's request, Contractor shall provide written report tabulating changes to the as-built drawings for the month.

1.4 PROJECT AS-BUILT DOCUMENT PROCEDURES

- A. Do not use Project As-Built Documents for construction purposes. Protect Project As-Built Documents from deterioration and loss. Provide access to Project As-Built Documents for Architect's reference.
 - 1. **Do not use** As Built Drawings and Specifications for Record Drawings and Specifications.
- B. Recording Procedures: Update drawings and specifications on a daily basis to record actual as-built conditions. Record information concurrently with construction progress. Do not conceal work until required information is accurately recorded.
- C. Store As-Built Documents and samples in a manner that protects them from damage and deterioration.
 - 1. Label and file As-Built Documents and samples in accordance with section number listings in Table of Contents. Label each document **PROJECT AS-BUILT** in neat, large, printed letters.
 - 2. Maintain any paper copies of As-Built Documents received from subcontractors, installers or others in clean, dry and legible condition.
 - 3. Make As-Built Documents and samples available for inspection upon request of Owner and/or Architect.

PART 2 PRODUCTS

2.1 AS-BUILT DRAWINGS

- A. As-Built Drawings: Maintain one set of marked up copies of the Contract Drawings and Shop Drawings.
 - 1. Preparation: Mark up as-built drawing pdf file to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained as-built data, whether individual or entity is installer, subcontractor or similar entity, to provide information for preparation of corresponding marked up as-built drawing file. Show actual installation conditions where installation varies from that shown originally.
 - a. Give attention to information on concealed elements difficult to identify or measure and record later.
 - b. Accurately record information in an acceptable drawing technique.
 - c. Record data as soon as possible after obtaining it.
 - d. Record and check the markup before enclosing concealed installations.
 - e. Cross reference record prints to corresponding shop drawings and archive photographic documentation.
 - 2. Content: Types of items requiring marking include, but are not limited to, the following:
 - a. Dimensional changes to Drawings.

- b. Revisions to details shown on Drawings.
 - c. Depths of foundations below first floor.
 - d. Locations and depths of underground utilities.
 - e. Revisions to routing of piping and conduits.
 - f. Revisions to electrical circuitry.
 - g. Actual equipment locations.
 - h. Duct size and routing.
 - i. Locations of concealed internal utilities.
 - j. Changes made by Change Order, Field Order or RFI Response
 - k. Changes made following Architect's written orders.
 - l. Details not on the original Contract Drawings.
 - m. Field records for variable and concealed conditions.
 - n. Record information showing actual installed locations on the work that is shown only schematically such as conduits, piping and ductwork.
3. Mark the Contract Drawings and Shop Drawings completely and accurately. Utilize personnel proficient at recording graphic information in production of marked up as-built drawing file.
 4. Mark up as-built drawings using pdf editor software capable of recording construction dimensions and information such as Bluebeam or equal acceptable to County.
 5. Mark important additional information that was either shown schematically or omitted from original Drawings.
 6. Bubble/cloud areas of changes and note Field Order numbers, alternate numbers, Change Order numbers, RFI numbers and similar identification, where applicable.
- B. As-built Digital Data Files: Immediately before inspection for Certificate of Substantial Completion, review marked up as-built pdf files with Architect. Make additions, revisions or corrections as directed by Architect. When authorized, prepare full set of corrected digital data files of the Contract Drawings:
1. Submittal and acceptance of complete as-built documentation is required prior to release of final payment.
 2. Format: Annotated PDF electronic file with comment function enabled. Identify and date file on first sheet and file name with the designation "PROJECT AS-BUILT" in a prominent location, but not obscuring any information.
 3. Incorporate changes and additional information previously marked on As-built drawings. Delete, redraw, and add details and notations where applicable.
 4. Refer instances of uncertainty to Architect for resolution.
 5. Architect will furnish Contractor one set of PDF files of the Contract Drawings for use in recording information at start of construction.
 - a. Refer to Section 01 33 00; Submittal Procedures for requirements related to use of Architect's digital data files.
 - b. Architect will provide data file layer information. Record as-built markups in separate layers according to Architect's instructions.
- C. Format: Identify and date each sheet in the As-Built drawing files; include the designation *PROJECT AS-BUILT DRAWING* in a prominent location.
1. Format: Annotated PDF electronic file with comment function enabled.
 2. As-Built Digital Data Files: Organize digital data information into separate references that correspond to each sheet of the Contract Drawings through digital bookmarks or binder in pdf file. Name each file with the sheet identification. Include identification in each digital data file.
 3. Identification: As follows:
 - a. Project and Owner name.
 - b. Date.
 - c. Designation PROJECT AS-BUILT DRAWINGS.
 - d. Name of Architect.
 - e. Name of Contractor.

- D. As-Built Prints: Print and submit one full-size set of As-Built Drawings from file with all markups visible. Organize As-Built prints into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.

2.2 AS-BUILT SPECIFICATIONS

- A. Preparation: Mark Specifications to indicate the actual product used in installation where installation varies from that indicated in Specifications, addenda, and contract modifications.
 - 1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later such as gypsum board, joint compound, items concealed in chases and above ceiling assemblies.
 - 2. Mark digital pdf copy of specifications with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected. Include reference to any approved submittals.
 - 3. Record the name of manufacturer, supplier, Installer, and other information necessary to provide a record of selections made.
 - 4. For each principal product, indicate whether As-Built Product Data has been submitted in operation and maintenance manuals as well.
 - 5. Note related Change Orders, As-Built Product Data, and As-Built Drawings where applicable.
- B. Format: Submit As-Built Specifications as annotated PDF electronic file and one printed paper copy of Specifications with pdf mark-ups shown, bound in binders. ALL documents to match Architect's specification format.

2.3 AS-BUILT PRODUCT DATA

- A. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.
 - 1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
 - 2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
 - 3. Note related Change Orders, approved Submittals, as-built Specifications, and as-built Drawings where applicable.
- B. Format: Submit record Product Data as annotated PDF electronic file. Include record Product Data directory organized by Specification Section number and title, electronically linked to each item of record Product Data.

2.4 AS-BUILT SAMPLES

- A. As-Built Samples: Determine with Architect and Owner which submitted Samples are to be maintained as Record Samples. Maintain and mark one set to indicate date of review and approval by Architect; note any deviations or variations between reviewed sample and installed product or material.

2.5 MISCELLANEOUS RECORD SUBMITTALS

- A. Assemble miscellaneous records required by the individual Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the work. Bind or file miscellaneous records and identify each, ready for continued use and reference. Include the following:
 - 1. Reviewed shop drawings, product data, and samples.
 - 2. Field test reports.

3. Inspection certificates and manufacturer's certificates.
 4. Inspections by authorities having jurisdiction (AHJ).
 5. Documentation of foundation depths.
 6. Special measurements or adjustments.
 7. Tests and inspections.
 8. Surveys.
 9. Design mixes.
- B. Format: Submit miscellaneous record submittals as one printed hard copy and one scanned PDF electronic file(s) of marked up miscellaneous record submittals. Include miscellaneous record submittals directory organized by Specification Section number and title, electronically linked to each item of miscellaneous record submittals through bookmarks in the PDF file.

PART 3 EXECUTION

3.1 RECORDING AND MAINTENANCE

- A. Recording: Maintain one copy of each submittal during the construction period for project record document purposes. Post changes and revisions to project as-built documents as they occur; do not wait until end of Project. Monthly reports of updates to As-Built will be required with or prior-to the Application for Payment. See section 1.3 E. above.
- B. Maintenance of Record Documents and Samples: Store as-built documents and Samples in the field office apart from the Contract Documents used for construction. Do not use project as-built and record documents for construction. Maintain as-built and record documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to any paper project as-built and record documents for Architect, Construction Administrator and Owner's reference during normal working hours. Maintain digital as-built files in agreed-upon cloud storage location accessible by Contractor, Architect, Owner, and Construction Administrator throughout the project.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. This section describes the building systems commissioning process and the general requirements and responsibilities that apply to implementation of commissioning without regard to specific systems, assemblies, or components.

1.2 DEFINITIONS

- A. Basis of Design (BOD): The documentation of design criteria and assumptions for systems, components, and methods chosen to meet the Owner's Project Requirements and applicable regulatory requirements, standards, and guidelines. The document includes narrative descriptions of the systems to be commissioned.
- B. Commissioning Authority (CxA): An independent agent hired directly by the owner and not otherwise associated with the Design Professional(s) or the Contractor. The CxA assists the Contractor with coordinating commissioning activities and witnesses the activities on behalf of the owner.
- C. Commissioning Issue (Cx Issues): A condition that affects, prevents or inhibits commissioning, and must be resolved to complete the commissioning process.
- D. Commissioning Issues List (Cx Issues List): A log maintained by the CxA listing all Deficiencies and Cx Issues documented during the commissioning process. All issues require action, correction and closure.
- E. Commissioning Plan (Cx Plan): A document that outlines the organization, coordination, and requirements of the commissioning process in more detail.
- F. Commissioning Coordinator (CxC): Individual within the GC's organization who plans, schedules, directs and coordinates all the GC's commissioning activities, and serves as the CxA's single point of contact for all administrative, documentation and coordination functions.
- G. Deferred Testing: Testing performed at a later time, due to partial occupancy, equipment, load, seasonal requirements, design or other site conditions that disallow the test from being performed.
- H. Deficiency: A condition in the installation or function of a component, piece of equipment or system that is not in compliance with the Contract Documents. A Deficiency will be considered a Cx Issue and documented on the Cx Issues List.
- I. Functional Performance Test (FPT): A test of the dynamic function, operation and control sequences of equipment and systems to verify system performance to the fullest extent. Systems are tested under various operating modes, such as during low cooling or heating loads, high loads, component failures, unoccupied, varying outside air temperatures, alarm, power failure, etc. The FPTs are performed using manual (direct observation) or monitoring methods.
- J. General Contractor (GC): The Contractor directly contracted to the owner with overall responsibility for the project and all commissioning activities described herein.
- K. Installation Verification (IV): Field verification and documentation of proper installation of system equipment, assemblies and components prior to Startup. Process is complete when systems are ready for Startup. Installation Verifications are organized under the System Readiness Checklist (SRC) forms.
- L. Monitoring: The recording of parameters (flow, current, status, pressure, etc) of equipment operation using data-loggers or the Trending capabilities of BAS or control systems.
- M. Owner's Project Requirements (OPR): A document describing the operational and functional requirements of a project, the expectations of how the facility will be used and

operated, and the equipment and system expectations and requirements, as defined by the owner. This document provides an explanation of the ideas, concepts, goals, criteria, and supporting information for the project.

- N. Percent Sampling: Witnessing the startup or testing of only a fraction of the total number of identical or near-identical pieces of equipment such as VAV boxes.
- O. Pre-Functional Checks & Tests: These are various checks and tests performed on a piece of equipment or system just before, during or after the initial Startup and operation. They are performed to confirm that the equipment and individual components were installed correctly and are working properly. Examples include checking fan rotation, sensor calibration, actuator testing, and spot temperature, pressure and electrical measurements. They also include system specific tests such as pipe system pressure tests, duct leakage tests, mechanical system test and balance (TAB) and electrical equipment independent third-party testing. They are organized under the System Readiness Checklist (SRC) forms and must be completed prior to FPTs.
- P. Startup: Initial starting or activating of equipment usually performed by the Trade Contractor or the Manufacturer's authorized representative.
- Q. System Readiness Checklist (SRC): A summary checklist, typically one page per equipment, covering the necessary commissioning tasks to verify that a system is ready for FPTs or system operation if no FPTs are performed. The tasks covered in the SRC include Installation Verification, Startup and Pre-functional Checks & Tests, and the Contractor completed forms for these tasks are attached to the equipment specific SRC. The SRC must be completed prior to conducting FPTs.
- R. TAB: Testing, Adjusting, and Balancing or Test and Balance
- S. Trade Contractor: Typically a subcontractor to the GC who provides and installs specific building components and systems and/or provides certain services.
- T. Trending: Monitoring using the Building Automation System (BAS) or a control system to aid in functional testing and verify system operation and performance under actual operating conditions.

1.3 SYSTEMS TO BE COMMISSIONED

- A. This specification section is applicable to the following systems and equipment to be commissioned in this project:
 - 1. HVAC systems.
 - 2. Building Automation System / HVAC System Controls
 - 3. Lighting system controls
 - 4. Domestic hot water heating systems and controls

1.4 SUMMARY DESCRIPTION OF COMMISSIONING

- A. Commissioning is a quality assurance process for verifying and documenting that building systems are installed and perform functionally as intended according to the OPR, BOD, and the requirements of the contract documents.
- B. Commissioning during the construction phase is intended to achieve the following specific objectives:
 - 1. Finalize the Commissioning Plan.
 - 2. Verify that applicable equipment and systems are installed according to the manufacturer's recommendations and to industry-accepted minimum standards and that they receive the required operational checkout and testing by the Trade Contractors.

3. Verify and document proper performance of equipment and systems.
 4. Verify that operation and maintenance documentation is provided and is complete.
 5. Develop a systems manual that provides future operating staff the information necessary to optimally operate the commissioned systems.
 6. Verify that the owner's facilities and operations personnel are trained per the contract document requirements.
- C. The commissioning process does not take away from or reduce the responsibility of the GC to provide a finished and fully functioning building. The GC has overall responsible to assure that all systems are properly tested and commissioned, and that all required commissioning documents are completed and provided to the owner.
- D. Project will meet the Commissioning Requirements of LEED-NC v2.2, Energy & Atmosphere, Prerequisite 1 and Credit 3. The GC, Trade Contractors, and suppliers are responsible to ensure all requirements for commissioning are met in their respective work.

1.5 COMMISSIONING PROCESS OVERVIEW

A. Cx Plan and Form Development

1. The Commissioning Authority (CxA) prepares a Preliminary Cx Plan during the project final design phase. The Cx Plan provides guidance in the execution of the commissioning process during construction.
2. Commissioning during construction begins with a kickoff meeting conducted by the CxA where the commissioning process and systems are reviewed. The Preliminary Cx Plan is presented and specific requirements and responsibilities are discussed.
3. The GC shall submit to the CxA, for review and approval, representative blank forms for completing Installation Verification, Startup, and Pre-Functional Checks and Tests. These forms can include standard Manufacturer or Trade Contractor installation checklists, detailed startup and checkout procedures, pre-functional test forms, and other project specific forms.
4. The CxA develops System Readiness Checklist (SRC) forms which list the Installation Verification, Startup, and Pre-Functional Checks & Tests required for each system and equipment to be commissioned. The SRC forms are submitted to the GC and Trade Contractors for review and comment.
5. The CxA will develop FPT procedures and forms based on the approved sequence of operation. These test procedures are submitted to the EOR, GC and Trade Contractors for review and comment.
6. The CxA will update and finalize the Cx Plan with equipment specific documentation and SRC and FPT forms.

B. Installation, Startup, Pre-Functional & System Readiness Activities

1. Meetings will be conducted throughout construction with Commissioning Team members, as required, to plan, coordinate, and schedule commissioning activities, review documentation, and resolve Cx Issues.
2. The Trade Contractors shall perform Installation Verification, Startup and Pre-Functional Check & Test activities. The Trade Contractors and the CxC shall document completion of these activities on the SRC forms and attach their completed Installation Verification, Startup, and Pre-Functional Checks and other Tests forms to the SRC.
 - a. In general, Installation Verification should be completed prior to Startup, but where appropriate, they can be completed into one activity.
3. The CxA will perform various inspections during the installation phase and back-checks of the completed Installation Verification. The CxA will also witness a

percent sampling of the Startups and Pre-Functional Checks & Tests, including TAB procedures.

C. Functional Testing

1. Once the SRC forms are completed, the FPTs are executed by the Trade Contractors and witnessed by the CxA. The FPTs may be achieved by any combination of Manual Testing or Monitoring via the BAS or control system Trending capabilities.

D. Deficiencies and Commissioning Issues

1. Throughout the process, the Commissioning Issues are recorded by the CxA on the Commissioning Issues List. The GC and its Trade Contractors shall correct Commissioning Issues and retest the system(s) without delay at no additional cost to the owner.

E. Training and Final Documentation

1. The GC will compile and complete the Operations & Maintenance Manuals per the contract documents requirements. The CxA will review for content and completeness and provide comments to the owner and GC.
2. The CxA will review and provide comment to the owner and GC on the specified training to be provided by the Trade Contractors and shall verify that it has been completed.
3. The CxA will develop the Systems Manual document with assistance from the GC and Trade contractors.
4. The CxA will complete the Final Construction Phase Commissioning Report and documentation for the Owner with assistance from the GC and Trade Contractors.

1.6 COMMISSIONING TEAM

- A. Owner's Representatives
- B. Design Professionals (DP).
- C. Commissioning Authority (CxA).
- D. General Contractor (GC)
- E. GC's Commissioning Coordinator (CxC)
- F. Trade Contractors responsible for specific types of systems being commissioned:
 1. Mechanical Contractor
 2. Electrical Contractor
 3. HVAC Controls Contractor
 4. Test, Adjust and Balance (TAB) Contractor
 5. Plumbing Contractor

1.7 RESPONSIBILITIES

- A. General:
 1. The Commissioning Team and all others involved in the commissioning process shall follow the Commissioning Plan, attend commissioning kickoff meeting, and additional commissioning meetings as necessary.
- B. Commissioning Authority (CxA)
 1. The primary role of the CxA is to oversee, organize and lead the commissioning team and assist the GC and Trade Contractors in executing the commissioning process.

2. Prepare the Cx Plan and develop the SRC and FPT forms.
 3. Work with the GC to schedule commissioning activities.
 4. Leads commissioning team meetings, prepare meeting agendas and distribute meeting minutes.
 5. Observe and inspect system and equipment installation, start-up, checkout, and testing for compliance with the OPR, BOD, and Contract Documents; review completion of commissioning documentation; and record any Deficiencies and Issues on the Cx Issues List.
 6. The CxA will witness the execution of the FPTs by the Trade Contractors. The CxA will witness one (1) re-test of any commissioned equipment or system.
 7. Is the authority on commissioning test results and other commissioning program elements completion.
 8. Review and comment on O&M documentation and training plans.
 9. Lead the effort in developing the Systems Manual.
 10. Assemble the commissioning documents and prepare the Commissioning Report.
 11. The CxA is not responsible for:
 - a. Design concept or design criteria
 - b. Review for code compliance
 - c. Design and construction scheduling
 - d. Cost estimating
 - e. Construction management
 - f. Providing tools and test equipment used for commissioning.
 - g. Scheduling Startup and Testing
 - h. Coordinating the work of Trade Contractors and any special testing agents
 - i. Performing Startup and Testing
- C. General Contractor:
1. The GC is responsible for all commissioning tasks to be performed, including tasks assigned to Trade Contractors. Ensure that all Trade Contractors execute commissioning responsibilities according to the Contract Documents, Cx Plan, and schedule.
 2. Include the cost for commissioning in the Guaranteed Maximum Price.
 3. Assign a CxC for the duration of the project with responsibilities outlined herein.
 4. Schedule and coordinate the commissioning meetings with the CxA.
 5. Plan, schedule, coordinate and facilitate the commissioning work performed by GC and Trade Contractors. Provide sufficient lead-time of at least 10 days to notify the CxA in advance of commissioning activities. Update the master construction schedule periodically with commissioning progress and activities.
 6. Review, comment and accept the Cx Plan prepared by the CxA.
 7. Furnish a copy of any construction related documents such as change orders, submittals, and shop drawings to the CxA. Electronic files are acceptable.
 8. Using SRC and FPT forms, document and certify that all work is complete and systems are installed, operational and functionally tested.
 9. Evaluate deficiencies identified on the Cx Issues List. Issues will be tracked according to the responsible entity. Collaborate with Trade Contractors and recommend corrective action. Assure all Cx Issues are resolved.

10. Prepare a training plan, submit to CxA and owner for review. Execute training of owner's personnel per approved training plan.
 11. Prepare O&M Manuals in accordance with the Contract Documents.
 12. Assist the CxA in developing the Systems Manual.
- D. Trade Contractors:
1. Provide commissioning submittal data, including manufacturer's installation checks and startup procedures, commissioning forms, and any other requested contract documentation for systems to be commissioned. Electronic files are acceptable.
 2. Attend commissioning meetings as directed by the CxA and GC's CxC to facilitate the commissioning process.
 3. Assign personnel with expertise and authority to act on behalf of the Contractor and schedule them to participate in and perform assigned commissioning tasks.
 4. Demonstrate and document proper system installation, startup and performance. Complete all Installation Verification, Startup and Pre-Functional Check & Test documentation clearly and legibly. Provide a copy of all forms to the CxC and CxA as part of completing the SRC forms.
 5. Address Trade Contractor applicable Cx Issues and Deficiencies promptly. All Installation Verification, Startup and Pre-Functional issues must be resolved before FPT can proceed.
 6. Assist CxA in preparing the FPT procedures, clarifying the operation and control of commissioned equipment where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.
 7. Review the FPT procedures to ensure feasibility, safety and equipment protection, and provide necessary written alarm limits and overrides to be used during the tests.
 8. Perform the FPTs. Execution of FPTs shall be witnessed by the CxC and CxA.
 9. Assist the CxA in collecting all requested Trend data associated with FPTs.
 10. Prepare a training plan, submit to CxA and owner for review. Execute training of owner's personnel per approved training plan.
 11. Prepare O&M Manuals according to the Contract Documents.
 12. Assist the CxA in developing the Systems Manual.
- E. Equipment Suppliers:
1. Provide all requested submittal data, including detailed installation checks, startup and checkout procedures and forms, and O&M manuals.
 2. Provide factory test data and documentation per the Contractor Documents.
 3. Assist in equipment testing per any agreements with Trade Contractors.
 4. Include all special tools and instruments specific for a piece of equipment which are only available from equipment supplier and required for testing the equipment according to Contract Documents.
 5. Provide information and support requested by the CxA regarding equipment sequences of operation and testing procedures.

1.8 SUBMITTAL REQUIREMENTS FOR COMMISSIONING

- A. Representative, blank commissioning forms for Installation Verification, Startup and Pre-Functional Checks & Tests.
1. The CxA reviews these GC submitted commissioning forms for completeness including any project specific requirements.

2. The CxA may request additional data, changes and/or additions to these forms to make sure they are complete prior to their use. If the GC submitted forms are not available or are not sufficient, then the CxA will provide forms based on the construction documents and specifications, manufacturer installation manuals and procedures, and/or industry standards or guidelines.
- B. Any equipment and construction submittals and shop drawings, including detailed sequences of operation, as requested by the CxA.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. All standard testing equipment required to perform Startup, Pre-Functional Checks & Tests and FPT shall be furnished by the Trade Contractor responsible for the systems.
- B. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerance specified in the Contract Documents. If not otherwise specified, the following minimum requirements apply:
 1. All equipment shall be calibrated according to the manufacturer's recommended intervals (or within one year if not otherwise specified) and recalibrated when dropped or damaged.
 2. Calibration tags shall be affixed or certificates readily available for all test equipment.

2.2 COMMISSIONING FORMS

- A. Installation Verification:
 1. Forms used to provide field verification and documentation of proper installation of equipment and system prior to formal Startup. Where appropriate, these forms may be combined with the Startup and Pre-functional Check & Test forms. Where appropriate, these forms can be checklists taken from the Manufacturer's installation manual.
- B. Startup and Pre-Functional Checks & Tests forms
 1. These forms primarily consist of Manufacturer and Trade Contractor Startup and Pre-Functional checkout sheets, and shall be used where required and appropriate. Where applicable, these forms include checks and tests of equipment controls.
 2. These also include forms for recording results from system specific tests such as pipe system pressure tests, duct leakage tests, mechanical system TAB, electrical equipment independent third-party testing, etc.
- C. System Readiness Checklist (SRC) forms:
 1. The SRCs are checklists which summarize and track the completion of Installation Verification, Startup, and Pre-Functional Checks & Tests prior to Functional Performance Tests. Completed Installation Verification, Startup, and Pre-Functional forms and reports are attached to the SRCs.
- D. Functional Performance Test (FPT) forms:
 1. The CxA will develop FPT forms with procedures to verify and document proper function, operation and control of each piece of equipment and system. FPT forms contain:
 - a. Specific step-by-step procedures to execute the test in a clear, sequential and repeatable format, including any control system point value or setpoint overrides required to simulate a test condition or sequence mode.
 - b. Any definitions of control system trend data to be collected and provided to the CxA in electronic format for analysis and review.

- c. The expected system response and acceptance criteria of proper performance with a Yes/No check box to allow for clearly marking whether or not proper performance of each part of the test was achieved.
- d. A section for recording actual system response, notes and comments.

PART 3 -EXECUTION

3.1 SCHEDULING AND COORDINATION

- A. The CxA will provide an initial list of commissioning events to the CxC for scheduling purposes.
- B. GC shall develop a detailed Start-up schedule for all systems to be commissioned and coordinate with CxA to include commissioning milestones. The GC shall integrate all commissioning activities and milestones into the master construction schedule with assistance from the CxA.
- C. The CxC shall provide sufficient notice to the CxA and Owner for scheduling and coordinating commissioning activities. A minimum 10 day's notice shall be provided to the CxA for witnessing equipment Start-ups, Pre-Functional Checks & Tests, and Functional Performance Testing.
- D. The Commissioning Team shall address scheduling problems and make necessary notification in a timely manner in order to expedite the commissioning process.

3.2 MEETINGS

- A. When commissioning team member attendance is required, as determined by the CxA and CxC, be punctual and attentive during the meeting.
 - 1. The CxA will conduct a commissioning kick-off meeting, usually within 60 days of the commencement of construction. All team members involved in the commissioning process shall attend the kick-off meeting.
 - 2. The CxA will plan other commissioning meetings as deemed necessary as construction progresses. These meetings will cover planning and coordination, and Commissioning Issues resolution.
 - 3. The frequency of meetings will vary through construction, but generally increase during start-up and commissioning activities.
- B. The CxA will write and distribute meeting minutes documenting the meeting discussion, conclusions, and actions for each team member.

3.3 SYSTEM READINESS: INSTALLATION VERIFICATION, STARTUP, PRE-FUNCTIONAL CHECKS & TESTS

- A. All tests and start-up procedures shall be conducted without compromise to human or equipment safety. The GC shall be responsible for the liability and safety of conducting all tests and startup.
- B. GC shall clearly identify and list any Deficiencies resulting from the Installation Verification, Start-up and Pre-Functional Checks & Tests on the SRC forms and immediately notify the CxA. Once Deficiencies are corrected and verified or tested, update and resubmit SRC and associated forms.

3.4 FUNCTIONAL PERFORMANCE TESTING

- A. Functional testing shall be performed and documented for 100% of all equipment in the scope of commissioning. At the discretion of the CxA and per the approved Cx Plan, the CxA may witness a percent (sample) of the functional tests for selected, multiple identical pieces of non-life-safety or non-critical equipment (example: VAV boxes).
- B. Prior to execution, the CxA will provide draft FPT forms with test procedures, to the GC

and Trade Contractor. The GC and Trade Contractor shall review and approve the tests procedures for feasibility, safety, equipment and warranty protection.

- C. Trade Contractors shall execute all FPTs per the approved test procedures on the FPT forms. All testing results shall be documented on the final FPT forms; the forms shall be signed and dated by the representative performing the tests. Off hours or weekend work may be required to complete the FPTs.
- D. GC shall coordinate all FPT with the CxA, and provide a minimum of 10 day's notice prior to conducting each system test.
- E. FPT for each system must be successfully completed and signed by the CxA prior to formal approval of system commissioning.
- F. FPT may be conducted using these approved test methods:
 - 1. Manually manipulating the equipment settings to observe performance.
 - 2. Overwriting control system sensor values to simulate a condition, such as overwriting the outside air temperature to be something other than it actually is.
 - 3. Altering setpoints to force equipment into a mode of operation to verify a sequence. For example, to see the AC compressor lockout work at an outside air temperature below 55F, when the outside air temperature is above 55F, a FPT would temporarily change the lockout setpoint to be 2F below the current outside air temperature.
 - 4. Using indirect indicators, such as readings from a control system screen reporting a damper is 100 percent open, for testing responses will be allowed only after the actual conditions represented by the indirect indicators have been directly verified, calibrated and documented on the SRC forms (as a pre-functional check/test).
 - 5. Monitoring performance by analyzing the control system Trend data. The CxA will analyze the control system Trend data.
- G. Setup:
 - 1. The Trade Contractor executing the test shall document the pre-test normal condition on the test form.
 - 2. Each function and test shall be performed under conditions that simulate actual conditions as close as is practically possible.
 - 3. The Trade Contractor executing the test shall provide all necessary materials, system modifications, etc. to produce the necessary flows, pressures, temperatures, etc. necessary to execute the test according to the specified conditions.
 - 4. At completion of the test, the Trade Contractor shall return all affected building equipment and systems to their pre-test normal condition.

3.5 COMMISSIONING ISSUES AND RE-TESTING

- A. During the Installation Verification, Startup, and Pre-Functional Checks & Tests, all Deficiencies and Issues shall be documented on the inspection and test forms in use, and will additionally be documented by the CxA on a Cx Issues List.
- B. Immediate correction of minor Deficiencies identified during testing may be allowed at the discretion of the CxA. In such cases the Deficiency and identified resolution must still be documented on the commissioning form in use.
- C. When Cx Issues are identified during FPT, the CxA will discuss with the executing Trade Contractor and/or CxC and determine whether testing can proceed or be suspended. The Commissioning Issue and any identified resolution will be documented on the test form in use in addition to the Commissioning Issues List.
- D. The CxA will maintain and update the Commissioning Issues List, and document the issues resolution process. Copies will be distributed to the GC, Owner, and Installation

Contractors as appropriate.

- E. All Deficiencies and Commissioning Issues shall be corrected promptly. The responsible party shall correct the issue and inform the GC and CxA in writing of the resolution and completion date. The CxA will record completion on the Commissioning Issues List and the CxC shall reschedule testing with the CxA and Trade Contractor. Testing shall be repeated until passing performance is achieved or the owner accepts the noted issue.
- F. When there is a dispute regarding a Cx Issue, whether it is valid or who is responsible, additional parties may be brought into the discussion as appropriate. The CxA shall have the final interpretive authority on Cx Issues and Deficiencies and the owner will have the final approval authority.
- G. The CxA may recommend solutions to Deficiencies and Commissioning Issues. However, the burden of responsibility to solve, correct and perform required retests is with the GC, Trade Contractors, and the Design Professional(s).
- H. Re-testing:
 - 1. For all Commissioning Issues identified during FPT, retesting is required to verify the resolution of the issue and to complete the FPT.
 - 2. The CxA will witness one (1) re-test for each equipment or system. A minimum 48 hour's notice is requested for scheduling any re-testing, though the CxA will work to accommodate a shorter timeframe if feasible.
 - 3. Any required retesting shall not be considered a justified reason for a claim of delay or for a time extension.

3.6 DEFERRED & SEASONAL TESTING

- A. Before or during the end of the first year Warranty Period, any Seasonal or Deferred Testing as defined in the Cx Plan, shall be completed as part of this contract. Tests shall be conducted by the Trade Contractor responsible for the equipment and systems, completed in the same manner as all other commissioning tests, and shall be witnessed and by the CxA.
- B. GC shall coordinate with CxA and Owner and schedule all Deferred and Seasonal Testing.
- C. GC shall make final adjustments to the as-builts for any modifications made during Deferred or Seasonal Testing.

3.7 TRAINING OF OWNER PERSONNEL

- A. The CxC shall coordinate and schedule the training for Owner Personnel. The CxC shall ensure that training is completed per the requirements of the construction documents and specifications.
- B. Trade Contractors responsible for specific equipment and system training shall submit a written training plan to the GC for all equipment and systems to be commissioned no less than (30) days prior to start of training. GC shall submit training plan(s) to CxA and Owner for review and approval. The training plan(s) will cover the following elements:
 - 1. Equipment and/or systems included in training
 - 2. Intended audience
 - 3. Location of training
 - 4. Subjects covered (description, duration of discussion, presentation methods, etc.)
 - 5. Instructor's name and qualifications
- C. The CxA shall review the training plans to verify compliance with the specifications.

- D. GC shall submit to CxA an 'attende signed' attendance sheets for each training session conducted.

3.8 PROJECT CLOSEOUT

- A. Upon completion of all commissioning activities, the CxA will prepare and submit to the Owner a Final Commissioning Report detailing all completed commissioning activities and documentation. The CxC shall support this effort by providing all GC and Trade Contractor commissioning documentation.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Geotechnical Engineering Report:
 - 1. Geotechnical Investigation Report, Humboldt County, New Courts Facility, Eureka, California by Kleinfelder, Inc. dated April 3, 1996.
 - 2. Update titled as Geotechnical Engineering Report Update and Supplemental Recommendations, HUMBOLDT COUNTY COMMUNITY CORRECTIONS RE-ENTRY RESOURCE CENTER, as prepared for this site by Mid Pacific Engineering, Inc., (MPE), dated November 29, 2019.

- B. Use of Data:
 - 1. This report was obtained for use in Project design and is referenced for Contractor's information only.
 - 2. Contents of the report referenced in this Section do not constitute a warranty of subsurface conditions.
 - 3. This report and addendum are attached to this Project Manual as "Appendix 3".
 - 4. Contractor shall visit the site prior to Bid to verify existing conditions.

1.2 QUALITY ASSURANCE

- 1. A Geotechnical Engineer/Testing Laboratory will be retained and paid by County to observe performance of work in connection with excavating, trenching, placing of compacted fill and backfilling operations and at the conclusion of the excavations to provide the following services.
 - 2. Determine if the soil at the bottom of the excavations is suitable as a base for the structure.
 - 3. Determine if compacted fill, backfill or any other required fill meets the requirements of the Specifications.
 - 4. Determine if imported fill materials comply with the specified requirements.
 - 5. Determine necessary adjustments in moisture content of soil, size of equipment, thickness of layers, and any tests as may be required to ensure a properly placed fill conforming to applicable requirements of Specifications.
 - 6. Observation and testing by Geotechnical Engineer/Testing Laboratory shall be provided during filling and compacting operations. Contractor shall give at least two working days' notice prior to beginning such operations, to allow proper scheduling of observation and testing work.
 - 7. Field density tests shall be performed by Geotechnical Engineer/Testing Laboratory after compaction of each layer of fill. Where compaction equipment has disturbed the surface to a depth of several inches, density tests shall be taken in the compacted material below the disturbed surface. Additional layers of fill shall not be placed until the field density tests indicate that the specified density has been obtained.

- B. If Contractor fails to meet technical or design requirements of the Contract Drawings and requirements/recommendations of Geotechnical Engineering Report, necessary readjustments shall be made until all work is deemed satisfactory by Geotechnical Engineer/Testing Laboratory, and County.
 - 1. No deviation from Specifications shall be permitted without written acceptance from Architect.

- C. Differing Site Conditions: Report differences observed between actual conditions at the site and the conditions indicated in Geotechnical Engineering Report immediately upon discovery. Report the nature and extent of differences to Owner's Representative orally to

permit early verification of the conditions, and concurrently submit it in writing.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Demolition and removal of selected elements.
2. Salvage of existing items to be reused or recycled.

1.2 DEFINITIONS

- A. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged or removed and reinstalled.
- B. Remove and Salvage: Carefully detach from existing construction, in a manner to prevent damage, and deliver to County.
- C. Remove and Reinstall: Detach items from existing construction, prepare for reuse, and reinstall where indicated.
- D. Existing to Remain: Existing items of construction that are not to be permanently removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.3 MATERIALS OWNERSHIP

- A. Unless otherwise indicated, demolition waste becomes property of Contractor.
- B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to County that may be uncovered during demolition remain the property of County.
 1. Carefully salvage in a manner to prevent damage and promptly return to County.

1.4 PREINSTALLATION MEETINGS

A. Predemolition Conference:

1. Inspect and discuss condition of construction to be selectively demolished.
2. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
3. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
4. Review areas where existing construction is to remain and requires protection.

1.5 INFORMATIONAL SUBMITTALS

- A. Proposed Protection Measures: Submit report, including drawings, that indicates the measures proposed for protecting individuals and property. Indicate proposed locations and construction of barriers.
- B. Inventory: Submit a list of items to be removed and salvaged and deliver to County prior to start of demolition.

C. Predemolition Photographs or Video: Submit before Work begins if necessary.

1.6 CLOSEOUT SUBMITTALS

A. Inventory: Submit a list of items that have been removed and salvaged.

B. Landfill Records: Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.

1.7 FIELD CONDITIONS

A. Conditions existing at time of inspection for bidding purpose will be maintained by County as far as practical.

B. Notify County of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

C. Hazardous Materials are not expected to be encountered in the Work.

1. If the Contractor encounters additional material in the course of work which Contractor has reason to believe may be hazardous waste, as defined by Section 25117 of the Health and Safety Code, Contractor shall immediately so notify the Owner's Representative in writing. Work in the immediate area of the suspected hazardous material shall be suspended until the OWNER authorizes it to be resumed. If such suspension delays the current controlling operation, the Contract will be granted an extension of time by means of a change order.

2. The Owner reserves the right to use other forces for exploratory work to identify and determine the extent of such material and for removing hazardous material from such area.

D. Storage or sale of removed items or materials on-site is not permitted.

E. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.

1. Maintain fire-protection facilities in service during selective demolition operations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Standards: Comply with ANSI/ASSE A10.6 and NFPA 241.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped before starting selective demolition operations.

B. Review record documents of existing construction provided by County. County does not guarantee that existing conditions are same as those indicated in record documents.

- C. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.
- D. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to County.

3.2 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

- A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.
- B. Existing Services/Systems to be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off indicated utility services and mechanical/electrical systems serving areas to be selectively demolished.
 - 1. Arrange to shut off indicated utilities with utility companies.
 - 2. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.

3.3 PREPARATION

- A. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
- B. Temporary Facilities: Provide temporary fencing and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
 - 1. Provide protection to ensure safe passage of people around selective demolition area.
 - 2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
- C. Temporary Shoring: Provide and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.
 - 1. Strengthen or add new supports when required during progress of selective demolition.

3.4 SELECTIVE DEMOLITION, GENERAL

- A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
 - 1. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.
 - 2. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
 - 3. Maintain adequate ventilation when using cutting torches.

4. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
 5. Dispose of demolished items and materials promptly.
- B. Removed and Salvaged Items:
1. Clean salvaged items.
 2. Pack or crate items after cleaning. Identify contents of containers.
 3. Store items in a secure area until delivery to County.
 4. Transport items to County's storage area.
 5. Protect items from damage during transport and storage.
- C. Removed and Reinstalled Items:
1. Clean and repair items to functional condition adequate for intended reuse.
 2. Pack or crate items after cleaning and repairing. Identify contents of containers.
 3. Protect items from damage during transport and storage.
 4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.
- D. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Project Manager, items may be removed to a suitable, protected storage location during selective demolition and reinstalled in their original locations after selective demolition operations are complete.

3.5 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

- A. Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals using power-driven saw, then remove concrete between saw cuts.
- B. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, then remove masonry between saw cuts.
- C. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, then break up and remove.

3.6 DISPOSAL OF DEMOLISHED MATERIALS

- A. General: Except for items or materials indicated to be reused, salvaged, reinstalled, or otherwise indicated to remain County's property, remove demolished materials from Project site and legally dispose of them.
1. Do not allow demolished materials to accumulate on-site.
 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
- B. Burning: Do not burn demolished materials.
- C. Disposal: Transport demolished materials off County's property and legally dispose of them.

3.7 CLEANING

- A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

3.8 SELECTIVE DEMOLITION SCHEDULE

- A. Existing Items to Be Removed: Per Construction Documents.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Concrete formwork, shoring, bracing, and anchorage.
- B. Concrete formwork accessories.
- C. Foam infill at elevated concrete.

1.2 REFERENCES

- A. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- B. Referenced Standards:
 - 1. ACI 301 – Specifications for Structural Concrete.
 - 2. ACI 347 – Guide to Formwork for Concrete.
 - 3. AHA A135.4 – Basic Hardboard.
 - 4. ASTM C177 – Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
 - 5. ASTM C203 – Standard Test Methods for Breaking Load and Flexural Properties of Block-Type Thermal Insulation.
 - 6. ASTM C272 – Standard Test Method for Water Absorption of Core Materials for Structural Sandwich Constructions.
 - 7. ASTM C518 – Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
 - 8. ASTM C578 – Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
 - 9. ASTM D696 – Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30°C and 30°C With a Vitreous Silica Dilatometer.
 - 10. ASTM D1621 – Standard Test Method for Compressive Properties of Rigid Cellular Plastics.
 - 11. ASTM E96 – Standard Test Methods for Water Vapor Transmission of Materials.
 - 12. ASTM E1643 – Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs.
 - 13. PS 1 – Construction and Industrial Plywood.

1.3 DESIGN REQUIREMENTS

- A. Design, engineer, and construct concrete formwork, shoring, and bracing in accordance with design and code requirements, resulting in cast-in-place concrete conforming to required shape, line, and dimension.

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's descriptive literature and product specifications for the following:
 - 1. Forms for architectural cast concrete finish.
 - 2. Foam infill.
 - 3. Accessories:
 - a. Chamfer strips.
 - b. Keyed construction joint.
 - c. Form ties.
 - d. Form release agent.
- B. Shop Drawings: Indicate dimensions, materials, bracing, and location of joints and ties.

1.5 QUALITY ASSURANCE

- A. Conform to ACI 347 for design, fabrication, erection, and removal of forms.
- B. Field Samples: Provide only as requested by Architect.
- C. Pre-Installation Meetings:
 - 1. Conduct pre-installation meeting in accordance with Division 01.
 - 2. Convene pre-installation meeting prior to commencing work of this Section.
 - 3. Coordinate work in this Section with work in related Sections.

PART 2 - PRODUCTS

2.1 FORM MATERIALS

- A. Architectural Cast Concrete Finish:
 - 1. Phenolic-faced plywood (minimum 167 g/m² on both faces); minimum 5/8 inch thickness; conforming to PS 1 APA HDO Plyform Class II or better; sound, undamaged sheets with clean, true edges, joints taped.
- B. Smooth Concrete Concealed from View: Plywood; 5/8 inch minimum thickness; conforming to PS 1 APA B-B Plyform Class II or better.
- C. Concrete Concealed from View:
 - 1. 2x lumber, plywood conforming to PS 1 APA Plyform Class II or better, tempered concrete form hardboard conforming to AHA A135.4, or other acceptable material.
- D. Foam Infill at Elevated Concrete: Type VII extruded polystyrene rigid foam insulation. Product: Dow Building Solutions Styrofoam Highload 60 or accepted equal with the following characteristics:
 - 1. Thermal Resistance, per inch, at 75 degrees F mean temp., ft²•h•degrees F/Btu, R-value, minimum: 5.0 per ASTM C177 and ASTM C518.
 - 2. Compressive Strength: 60 psi, minimum per ASTM D1621.

3. Water Absorption, percent by volume, maximum (24 hour water immersion): 0.3 per ASTM C272.
4. Water Vapor Permeance: 0.8 perms per ASTM E96.
5. Maximum Use Temperature: 165 degrees F.
6. Coefficient of Linear Thermal Expansion, in/in• degrees F: 3.5×10^{-5} , per ASTM D696.
7. Flexural Strength: 75 psi minimum per ASTM C203.
8. Complies with ASTM C578, Type VII.
9. Edges: Square.
10. Thickness: As indicated on Drawings. Taper insulation where shown on Drawings.

2.2 ACCESSORIES

- A. Chamfer Strips: Wood, metal, or rubber strips; size as shown on Drawings, minimum 3/4 inch by 3/4 inch.
- B. Expansion Joint Filler: Refer to Section 03 30 00.
- C. Foam Board Separation: Expanded polystyrene in size and thickness to suit application.
- D. Keyed Construction Joint: Minimum 24 gauge galvanized steel; shaped with formed key (minimum 1-1/2 inch) for load transfer; and with knockouts for dowel placement.
 1. Basis-of-Design Product: G-33 Screed Key Joint by Dayton/Richmond Concrete Accessories, Miamisburg, OH; 800-745-3700; www.daytonrichmond.com. Provide the named product or accepted equal.
- E. Form Ties: Provide as indicated and as required.
 1. Stainless Steel Form Tie System:
 - a. Stainless Steel Snap Tie, Product No. A-44 by Dayton Superior, Miamisburg, OH; 800-745-37000; www.daytonsuperior.com.
 - b. Stainless Steel Snap Ties by Meadow Burke, Tampa, FL; 877-518-7665, www.meadowburke.com.
 - c. Or accepted equal.
- F. Plastic Stakes: At Contractor's option, solid plastic stakes may be used in lieu of wood and steel stakes. Provide solid plastic stakes for use in areas with continuous vapor retarder.
 1. Basis-of-Design Product: VaporStake™ by VaporStake LLC, Chino Hills, CA; 714-519-4211, www.vaporstake.com.
 2. Material: Non-corrosive, leak-resistant, solid PVC, with one pointed end and multiple pre-drilled holes for nailing; diameter and length as recommended by stake manufacturer, and as required by field conditions.
- G. Nails, Spikes, Lag Bolts, Through-Bolts, Anchors: Sized as required, of sufficient strength and character to maintain formwork in place while placing concrete.

- H. Spreaders: Metal; use of wood spreaders will not be permitted.
- I. Form Release Agent: Commercially formulated form release agents that will not bond with, stain or adversely affect concrete surface, and will not impair subsequent treatment of concrete surfaces, nor impede the wetting of surfaces to be cured with water or curing compounds. Product shall meet the VOC requirements at the location of use.
 - 1. Product: Duogard as manufactured by W.R. Meadows or accepted equal.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine job site conditions and verify field dimensions.
- B. Report unacceptable conditions to Architect. Begin installation only when unacceptable conditions have been corrected.

3.2 EARTH FORMS

- A. Concrete may be placed against cut earth where feasible, conforming to the following criteria:
 - 1. Earth form trenches shall be able to stand without caving in.
 - 2. Sluffage will not be permitted.
 - 3. When, in the opinion of the Building Official and Architect, soil conditions do not require formwork per CBC Section 1808.8.5.
- B. Hand trim sides and bottoms of earth forms. Remove loose soil prior to placing concrete.

3.3 FOAM INFILL AT ELEVATED CONCRETE

- A. Install per manufacturer's recommendations in the location and thickness as indicated on Drawings.

3.4 FORMWORK ERECTION

- A. Erect formwork, shoring, and bracing in accordance with ACI 301.
- B. Provide bracing to ensure stability of formwork. Shore or strengthen formwork subject to overstressing by construction loads.
- C. Arrange and assemble formwork to permit ease of dismantling and stripping and prevent damage to concrete during stripping.
- D. Align joints and make watertight. Keep form joints to a minimum.
- E. Obtain approval from Architect before framing openings not specifically indicated on Drawings.
- F. Perform electrical and mechanical work requiring concrete formwork under provisions of this Section.
- G. Stakes (wood and metal) used to support formwork or reinforcement, will not be permitted to occur within finished concrete work.

1. Pulling of stakes and puddling concrete in after concrete placement will not be permitted.
2. Locate non-plastic stakes appropriately to prevent embedment of stakes in the concrete after placement.
3. Plastic stakes, when used in areas with vapor retarder, shall not be removed.
4. Seal plastic stakes with vapor retarder manufacturer's sealing mastic in accordance with ASTM E1643 and Section 03 30 00 requirements.
 - a. Dip pointed side of plastic stake in mastic before driving through vapor retarder to seal the stake perimeter at penetration.

3.5 FORM RELEASE AGENT APPLICATION

- A. Apply form release agent on formwork in accordance with manufacturer's recommendations.
- B. Apply prior to placement of reinforcing steel, anchoring devices and embedded items.
- C. Do not apply form release agent where concrete surfaces will receive special finishes or applied coverings that are affected by agent.
- D. Soak inside surfaces of untreated forms with clean water. Keep surfaces coated prior to placement of concrete.

3.6 INSERTS, EMBEDDED PARTS AND OPENINGS

- A. Locate and set in place items which will be cast directly into concrete.
- B. Coordinate work of other Sections such as but not limited to openings, slots, reglets, recesses, chases, sleeves, bolts, anchors and other inserts.
- C. Install accessories in accordance with manufacturer's instructions, straight, level and plumb. Ensure items are not disturbed during concrete placement.
- D. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection. Locate openings at bottom of forms to allow flushing water to drain.

3.7 CONSTRUCTION JOINTS

- A. Locate construction joints so as not to impair the strength of the structure and only at locations indicated on Drawings and as acceptable to Architect. Form keys in cold joints as shown or required.

3.8 UNDERSLAB VAPOR RETARDER

- A. Protect underslab vapor retarder from damage at all times.

3.9 FORMWORK CLEANING AND INSPECTION

- A. Inspect erected formwork, shoring and bracing to ensure that work is in accordance with formwork design and that supports, fastenings, wedges, ties, and embedded items are secure to prevent displacement and distortions.

- B. Clean forms and adjacent surfaces as formwork is erected and prior to concrete placement. Remove wood chips, sawdust, dirt, and other debris.
- C. Flush with water or use compressed air to remove remaining foreign matter. Ensure that water and debris drain through cleaning ports.
- D. Close temporary openings with tight fitting panels, flush with inside face of forms and neatly fitted so joints will not be apparent in exposed concrete surfaces.

3.10 ADJUSTMENTS

- A. When a concrete pour has been stopped for a sufficient length of time so that shrinkage or warp has separated the forms and the concrete, provide for form adjustment to draw the forms into firm contact with concrete before placing additional concrete. Take precautions to prevent any shoulder or ledge from being formed at a cold joint.

3.11 FORM REMOVAL

- A. Do not remove forms or bracing until concrete has gained sufficient strength to carry its own weight and imposed loads.
- B. Remove forms progressively and in accordance with ACI 347.

3.12 FORM REUSE

- A. Forms in good condition may be reused.
- B. Clean and inspect forms prior to reuse. Do not re-use split, warped, delaminated, or otherwise damaged forms that will impair surface condition and quality of cast concrete exposed to view.
- C. Do not reuse wood formwork more than two times for architectural finish exposed concrete and three times for concrete surfaces to be exposed to view. Do not patch formwork.

3.13 FORMWORK TOLERANCES

- A. Construct formwork to maintain tolerances required by ACI 347.
- B. Concrete work out of alignment, level or plumb will be cause for rejection of the whole work affected and, if so rejected, such work shall be removed and replaced, as directed by Architect, at no cost to Owner.
- C. All concrete exposed to view, except as otherwise indicated and specified shall have a smooth finish of uniform texture, free from form marks or other visible irregularities and free from form coating, oils or other matter that will prevent bonding of patching work, painting or other finish materials.

END OF SECTION

PART 1 GENERAL

1.1 SUMMARY

- A. This Section describes the requirements for providing accessories for concrete including drilled-in anchors, inserts, and waterstops.
- B. References:
 - 1. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only. Refer to Division 01 for definitions, acronyms, and abbreviations.
 - 2. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
 - 3. American Society of Testing Materials (ASTM):
 - a. ASTM A36 – Structural Steel.
 - b. ASTM A193-B7 – High Strength Structural Steel.
 - c. ASTM A307 – Carbon Steel Bolts and Studs.
 - d. ASTM A615 – Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
 - e. ASTM B633 – Electrodeposited Coatings of Zinc on Iron and Steel.
 - f. ASTM B695 – Coatings of Zinc Mechanically Deposited on Iron and Steel.
 - g. ASTM C881 – Epoxy-Resin-Based Bonding Systems for Concrete.
 - h. ASTM E488 – Strength of Anchors in Concrete and Masonry Elements.
 - i. ASTM E1512 – Testing Bond Performance of Adhesive-Bonded Anchors.
 - j. ASTM F593 – Stainless Steel Bolts, Hex Cap Screws, and Studs.
 - 4. American Concrete Institute: (ACI):
 - a. ACI 318 – Building Code Requirements for Structural Concrete.
 - b. ACI 355.2 – Standard for Evaluating the Performance of Post-Installed Mechanical Anchors in Concrete.
 - c. ACI 355.4 – Qualification of Post-Installed Adhesive Anchors in Concrete.
 - 5. International Code Council (ICC):
 - a. ICC AC01 – Acceptance Criteria for Expansion Anchors in Concrete and Masonry Elements.
 - b. ICC AC58 – Acceptance Criteria for Adhesive Anchors in Masonry Elements.
 - c. ICC AC60 – Acceptance Criteria for Unreinforced Masonry Anchors.
 - d. ICC AC70 – Acceptance Criteria for Powder Driver Fasteners in Concrete, Steel and Masonry Elements.
 - e. ICC AC106 – Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Concrete or Masonry.
 - f. ICC AC193 – Acceptance Criteria for Mechanical Anchors in Concrete Elements.
 - g. ICC AC308 – Acceptance Criteria for Post-installed Adhesive Anchors in Concrete Elements.
 - 6. Federal Specifications A-A-1922A, A-A-1923A, A-A-55614 for Expansion and Shield-Type Anchors.

1.2 SUBMITTALS

- A. All submittals shall be made under the provisions of Division 1 – General Requirements.

1.3 QUALITY ASSURANCE

- A. Perform Work in accordance with the California Building Code.
- B. Obtain materials from the same source throughout the Work.
- C. Anchors should be listed as ICC or IAPMO approved for material being installed in.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to site in manufacturer's packaging, undamaged and with installation instructions.
- B. Store materials to prevent damage or deterioration.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Waterstops: Rubber flat, dumbbell type or center bulb type at construction joints and other joints where indicated, size to suit joints.
- B. Drilled-In Anchors: Acceptable manufacturers for the following products include, but are not limited to, Simpson Anchor Systems and Hilti. Verify with the manufacturer's installation instructions and specifications for more information including hollow substrate requirements, moisture of concrete, hole size and type of bit used to drill holes.
 - 1. Expansion Anchors:
 - a. Cracked Concrete Wedge Anchors: Anchors shall be designed in accordance with ACI 318, Appendix D, which requires anchors to be evaluated per ACI 355.2. The anchors shall also be tested in accordance with AC 193 for all mandatory and optional tests, specifically seismic and wind testing.
 - b. Wedge Anchors: Anchors shall meet the physical requirements of Federal Specification A-A-1923A, Type 4. Anchors shall have an ICC or IAPMO evaluation report and be tested in accordance with AC 01 for seismic and wind loading, combined shear and tension loads, and critical and minimum edge distance. Anchor materials include carbon steel (zinc plated or mechanically galvanized), Type 304 or 316 stainless steel complying with ASTM A493, or Type 303 stainless free-machine steel complying with ASTM A582.
 - c. Sleeve Anchors: Anchors shall meet the physical requirements of Federal Specification A-A-1922A. Anchors shall have an ICC evaluation report and be tested in accordance with AC 01 for static loading and critical and minimum edge distance and spacing. Anchor materials include carbon steel with electroplated zinc finish, Type 304 stainless steel complying with ASTM A493.
 - d. Flush-Mount, Internally Threaded Shell Anchors: Anchors shall meet the physical requirements of Federal Specification A-A-55614, Type I. Anchors shall have an ICC evaluation report and be tested in accordance with AC 01 for seismic and wind loading, combined shear and tension loads, and critical and minimum edge distance and spacing. Anchor materials include carbon steel with electroplated zinc finish, Type 316 stainless steel complying with ASTM A493, or Type 303 stainless free-machine steel complying with ASTM A582.
 - 2. Adhesive Anchors: Adhesive anchors shall consist of and insert and an adhesive formula. Inserts shall meet the requirements of ASTM A307, A36, A193-B7, or F1554 for threaded rods or ASTM A615 or A706 for reinforcing steel. For exterior conditions the threaded insert shall be galvanized per ASTM A153 or be a 300 series stainless steel with nuts and washers of the same material. Use an adhesive material meeting one of the following criteria.
 - a. Epoxy Adhesives: Adhesives shall be a cartridge type, two component, solid epoxy based system dispensed and mixed through a static mixing nozzle supplied by the manufacturer. Anchors shall meet the minimum requirements of ASTM C881, have an ICC evaluation report and be tested in accordance with AC 308 for seismic and wind loading, long term creep at elevated temperatures, static loading at elevated temperatures, damp and water-filled holes, freeze-thaw conditions, and critical and minimum edge distance and spacing. Installation temperatures shall be verified with the manufacturer's instructions.
 - b. Acrylics Adhesives: Adhesive shall be a cartridge type, two component, acrylic

based system dispensed and mixed through a static mixing nozzle supplied by the manufacturer. Anchors shall meet the minimum requirements of ASTM C881, have an ICC evaluation report and be tested in accordance with AC 308 for seismic and wind loading, long term creep at elevated temperatures, static loading at elevated temperatures, damp and water-filled holes, freeze-thaw conditions, and critical and minimum edge distance and spacing. Installation temperatures shall be verified with the manufacturer's instructions.

- c. Encapsulated Adhesives: Capsule shall be a two-component, vinylester based adhesive capsule-within-a-capsule system supplied in a manufacturer's standard packaging. Capsule adhesive shall be tested in accordance with AC 308 for long term creep at elevated temperatures and critical and minimum edge distance and spacing. Installation temperatures shall be verified with the manufacturer's instructions.
3. Concrete Screw Anchors:
 - a. Self-Tapping Concrete Screw Anchors: Anchors shall have 360-degree contact with the concrete surface and shall not require oversized or undersized holes for installation. Fastener material shall be steel complying with AISI 10B21 or 15B21, heat-treated and zinc-plated, or mechanically galvanized. Anchors shall have an ICC report and be tested in accordance with AC 106 for static tension and shear loading and critical and minimum edge distance and spacing.
4. Powder Actuated Fasteners:
 - a. Fasteners shall be of drive pin and threaded stud types and be manufactured from AISI 1060 to 1065 steel with an electroplated zinc finish. The minimum yield strength shall be 90,000 psi.
 - b. Fasteners shall not be used where spalling of the concrete will occur. If spalling does occur, patch as required per Section 03 01 00.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Waterstops: Provide waterstops in construction joints as indicated.
 1. Install waterstops to form continuous diaphragm in each joint.
 2. Make provisions to support and protect waterstops during progress of work.
 3. Fabricate field joints in waterstops in accordance with manufacturer's printed instructions.
- B. Anchors:
 1. Install all anchors per the manufacturer's instructions with the appropriate tools.
 2. Where holes are drilled for anchors, holes shall be accurately and squarely drilled and shall be cleaned per the manufacturer's instructions.

3.2 FIELD QUALITY CONTROL

- A. Provide continuous inspection of the installation of all anchors per 2019 CBC Table 1705.3.
- B. Pull or torque test anchors per the requirements of the 2019 CBC Section 1913.2.11 and ACI 318 Appendix D and the tables provided on General Structural Note's sheets. Torque testing of adhesive anchors is not permitted.
- C. Load test 100% of all anchors used in a structural condition (i.e. anchors or holdown bolts). See General Structural Note's sheet for load test values.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Steel reinforcement and accessories for concrete and concrete unit masonry.

1.2 REFERENCES

- A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only. Refer to Division 01 for definitions, acronyms, and abbreviations.
- B. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.

C. Referenced Standards:

1. ACI 117 – Specifications for Tolerances for Concrete Construction and Materials.
2. ACI 301 – Specifications for Structural Concrete.
3. ACI 318/318R – Building Code Requirements for Structural Concrete and Commentary.
4. ACI SP-66 – ACI Detailing Manual.
5. ASTM A615/A615M – Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
6. ASTM A706/A706M – Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
7. ASTM A1064/A1064M – Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
8. AWS D1.4 – Structural Welding Code – Reinforcing Steel.
9. CRSI Manual of Standard Practice.
10. Wire Reinforcement Institute (WRI) Manual of Standard Practice.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's descriptive literature, installation instructions, and product specification for the following products:
1. Mechanical splicing devices.
 2. Bar supports.
- B. Placement Drawings:
1. Prepare in accordance with ACI SP-66.
 2. Indicate bar sizes, spacing, locations, and quantities of steel reinforcement and wire fabric, bending and cutting schedules, and supporting and spacing devices.
 3. Identify placement drawings with reference to sheet and detail numbers from the Contract Documents.

4. Do not use scaled dimensions from Drawings to determine lengths of steel reinforcement.
 5. Contractor shall be responsible for correctness and completeness of steel reinforcing requirements.
 6. Begin fabrication only when placement drawings have been accepted.
- C. Samples:
1. Bar supports: One for each type and grade.
 2. Mechanical splicing devices: One of each type.
- D. Quality Assurance/Control Submittals:
1. Submit certified copies of mill test reports of reinforcing materials analysis to Owner's testing agency.

1.4 QUALITY ASSURANCE

- A. Perform work in accordance with CRSI Manual of Standard Practice; ACI 301; and 2019 California Building Code (CBC) Chapter 17 "Special Inspections and Tests", and Chapter 19 "Concrete", and as follows:
1. Steel Reinforcement, Tests and Materials: CBC Section 1903 "Specifications for Tests and Materials".
 2. Anchorage: CBC Section 1910.5.
 3. Reinforcing Bar Welding: Per Section 1705, Table 1705.3 "Required Special Inspections and Tests of Concrete Construction".
- B. Structural Tests and Inspections: Refer to project Enforcement Agency Structural Tests and Inspection Sheet.
- C. Pre-Installation Meetings:
1. Conduct pre-installation meeting in accordance with Division 01.
 2. Convene pre-installation meeting prior to commencing Work of this Section.
 3. Coordinate Work in this Section with Work in related Sections.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver steel reinforcement in bundles marked with identification tags.
- B. Handle and store materials to prevent damage and contamination, excessive rusting or coating with grease, oil, or other objectionable materials.
- C. Store steel reinforcement, fabricated assemblies, and accessories off the ground on platforms, skids, or other supports.
- D. Deliver and store welding electrodes in accordance with AWS D1.4.

PART 2 - PRODUCTS

2.1 STEEL REINFORCEMENT

- A. Reinforcing Steel: ASTM A615/A615M, Grade 60, low-alloy deformed steel bars.

- B. Reinforcing Steel Indicated to be Welded: ASTM A706/A706M, Grade 60, low-alloy deformed steel bars.
- C. Plain Steel Wire (for Spiral Reinforcement): ASTM A1064/1064M.
- D. Deformed Steel Wire: ASTM A1064/A1064M.
- E. Welded Wire Fabric: ASTM A1064/1064M; 65 ksi minimum yield strength; fabricated from as-drawn steel wire into flat sheets (rolled fabric not permitted).
 - 1. Size: As indicated on Drawings.
- F. Tie Wire: Black annealed steel wire; No. 16 gauge.

2.2 ACCESSORIES

- A. Bar Supports (Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place): Provide in accordance with CRSI Manual of Standard Practice from steel wire, plastic, or precast concrete or fiber-reinforced concrete of equal to or greater compressive strength than surrounding concrete. Provide as follows:
 - 1. Footings: Precast concrete blocks with tie wires.
 - 2. Slab on ground: Precast concrete blocks, plastic coated steel fabricated with bearing plates, or specifically designed wire-fabric supports fabricated of plastic.
 - 3. Where legs of wire bar supports contact forms: CRSI Class 1 plastic-protected or CRSI Class 2 stainless steel bar supports.
 - 4. Where support is no closer to concrete surface than 1/2 inch: CRSI Class 3 wire supports.
 - 5. Supports placed against ground: Precast concrete blocks not less than 4 inch square with embedded wire.
- B. Welding Materials For Reinforcing Steel:
 - 1. Weld Filler Material: AWS D1.4; low hydrogen, 80 ksi tensile strength.
- C. Mechanical Splices: Splicing devices capable of developing 125 percent of the specified yield strength of the bar in compression and tension.
 - 1. Metal Sleeve with Cast Filler Metal:
 - a. Acceptable Product: Cadweld Rebar by Erico International Corporation, Solon, OH; 800-248-2677; www.erico.com, or accepted equal.
 - 2. Mechanical Threaded Connections: Provide threaded mechanical connections using a metal coupling sleeve with internal threads.
 - a. Acceptable Product: Lenton Couplers by Erico International Corporation DB-SAE Dowel Bar Splicers by Dayton Concrete Accessories, Miamisburg, OH; 800-745-3700, www.daytonconcreteacc.com, or accepted equal.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine job site conditions and verify field dimensions.

- B. Report unacceptable conditions to Architect. Begin installation only when unacceptable conditions have been corrected.

3.2 PREPARATION

- A. Clean steel reinforcement of rust and mill scale, earth, moisture, and other foreign materials before fabrication or placement.

3.3 STEEL REINFORCEMENT FABRICATION

- A. Fabricate to shapes, dimensions, and tolerances in accordance with accepted placement drawings conforming to CRSI Manual of Standard Practice, ACI SP-66, ACI 318/318R, ACI 117, and CBC Chapter 19.
- B. Standard Hooks and Bends: Conform to ACI 318/318R.
- C. Bending: Cold bend steel reinforcement in the field or at the mill. Heating for bending is not permitted unless otherwise specifically allowed by Architect.
- D. Reinforcement must not be straightened or re-bent without approval of Structural Engineer of Record (SEOR) and Authority Having Jurisdiction.
- E. Weld steel reinforcement in accordance with AWS D1.4.

3.4 PLACEMENT

- A. Place steel reinforcement in accordance with accepted placement drawings in conformance with tolerances specified in ACI 117.
- B. Install steel reinforcement in largest practical lengths. Accurately position, support, and secure reinforcement against displacement. Locate support reinforcement with bar supports to maintain minimum concrete cover.
- C. Secure reinforcement against displacement within tolerances permitted in ACI 318, Article 7.5.2. Point wire tie ends away from forms.
- D. Concrete Cover: Refer to Drawings. Cover tolerances shall comply with ACI 117.
- E. Laps: Refer to Drawings.
 - 1. Offset laps in adjacent bars.
- F. Splices:
 - 1. Splice reinforcing as shown.
 - 2. Tie lap splices securely to prevent displacement during concrete placement.
 - 3. Install mechanical splice in accordance with manufacturer's written instructions.
 - 4. Locate splices only where shown and accepted by Architect.
- G. Welding:
 - 1. Welding is not permitted unless specifically detailed on Drawings or accepted by Architect.
 - 2. Employ shielded metal-arc method. Comply with AWS D1.4.

3. Welding is not permitted on bars where the carbon content is not known or is determined to exceed 0.75 percent.
 4. Welding is not permitted within two bar diameters of any bent portion of a bar which has been bent cold.
 5. Welding of crossing bars is not permitted.
- H. Maintain minimum clear distance between parallel bars at not less than 1-1/2 times nominal bar diameter, 1-1/2 times maximum size of coarse aggregate, or 1-1/2 inch.
- I. Dowels: Place where indicated on Drawings. Grease loose end to prevent concrete from bonding to dowel. Sleeves may be used when accepted by Architect.
- J. Dowels for Masonry Reinforcement: Coordinate with masonry work reinforcement requirements. Match masonry reinforcing steel. Refer to Section 04 22 00.
- K. Welded Wire Fabric: Install in longest practical lengths on bar supports to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps to avoid continuous laps in either direction. Tie lap joints at 12 inches on center.
- L. Field Adjustments: Move steel reinforcement as necessary to avoid interference with other reinforcing steel or other embedded items within accepted tolerances.
1. Sleeves and embedded items: Do not cut bars to clear sleeves or slots through slabs or walls. Wrap bars around these openings.
 2. Openings: Compensate for steel reinforcement terminated at openings in slabs by placing one half of steel reinforcement terminated on each side of openings for the full span length.
 3. Steel reinforcement moved to avoid interference with other reinforcements, conduits, or embedded items, including additional steel reinforcement to meet structural requirements are subject to inspection and approval before concrete placement.

3.5 FIELD QUALITY CONTROL

- A. General: Comply with requirements of Division 01.
- B. Testing Service: Owner will select and pay for independent testing agency, which will perform the following:
1. Inspect shop and field welding per AWS D1.4, including checking materials, equipment, procedures, and welder qualifications.
 2. Inspector shall employ non-destructive testing or any other aid to visual inspection deemed necessary to assure adequacy of weld.
 3. Additional requirements for testing and inspection: Refer to Structural Drawings.
- C. Placement of steel reinforcement shall be inspected where noted on Structural Drawings.

3.6 PROTECTION

- A. Protect steel reinforcement from damage and displacement.
- B. Protect for potential rust staining of adjacent surfaces. Wrap steel reinforcement with impervious tape or other methods as accepted by Architect. Remove protective cover and clean reinforcement before concrete placement.
- C. Install safety caps on all exposed ends of vertical steel reinforcement that pose a danger to life safety.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Cast-in-place concrete.
 - 1. Architectural concrete at exposed locations.
- B. Concrete admixtures, including pigments for integral color concrete.
- C. Curing and surface slab treatment.
- D. Grouting, bonding, and patching materials.
- E. Accessories:
 - 1. Expansion joints.
- F. Precast concrete wheel stops.

1.2 REFERENCES

- A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only. Refer to Division 01 for definitions, acronyms, and abbreviations.
- B. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- C. ACI publications 221R, 302.1R, 302.2R, 303R, 304R, 305R, 306R, and 309R contain recommended practices for concrete work. Submit any proposed deviations from these recommendations to Architect for review prior to commencing concrete work.
- D. Referenced Standards:
 - 1. ACI 117 – Specification for Tolerances for Concrete Construction and Materials.
 - 2. ACI 221R – Guide for Use of Normal Weight and Heavyweight Aggregates in Concrete.
 - 3. ACI 301 – Specifications for Structural Concrete.
 - 4. ACI 302.1R – Guide for Concrete Floor and Slab Construction.
 - 5. ACI 302.2R – Guide for Concrete Slabs that Receive Moisture-Sensitive Flooring Materials.
 - 6. ACI 303R – Guide to Cast-In-Place Architectural Concrete Practice.
 - 7. ACI 303.1 – Standard Specification for Cast-in-Place Architectural Concrete.
 - 8. ACI 304R – Guide for Measuring, Mixing, Transporting, and Placing Concrete.
 - 9. ACI 305R – Guide to Hot Weather Concreting.
 - 10. ACI 305.1 – Specification for Hot Weather Concreting.
 - 11. ACI 306R – Guide to Cold Weather Concreting.
 - 12. ACI 306.1 – Standard Specification for Cold Weather Concreting.

13. ACI 309R – Guide for Consolidation of Concrete.
14. ACI 318 – Building Code Requirements for Structural Concrete.
15. ACI SP-15 – Field Reference Manual: Specifications for Structural Concrete ACI 301-10 with Selected ACI and ASTM References.
16. ASTM C31/C31M – Standard Practice for Making and Curing Concrete Test Specimens in the Field.
17. ASTM C33 – Standard Specification for Concrete Aggregates.
18. ASTM C39/C39M – Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
19. ASTM C94/C94M – Standard Specification for Ready Mixed Concrete.
20. ASTM C109 – Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens).
21. ASTM C114 – Standard Test Methods for Chemical Analysis of Hydraulic Cement.
22. ASTM C143/C143M – Standard Test Method for Slump of Hydraulic Cement Concrete.
23. ASTM C150 – Standard Specification for Portland Cement.
24. ASTM C157/C157M – Standard Test Method for Length Change of Hardened Hydraulic-Cement, Mortar and Concrete.
25. ASTM C171 – Standard Specification for Sheet Materials for Curing Concrete.
26. ASTM C172 – Standard Practice for Sampling Freshly Mixed Concrete.
27. ASTM C309 – Standard Specification for Liquid Membrane Forming Compounds for Curing Concrete.
28. ASTM C330 – Standard Specification for Lightweight Aggregates for Structural Concrete.
29. ASTM C348 – Standard Test Method for Flexural Strength of Hydraulic-Cement Mortars.
30. ASTM C494/C494M – Standard Specification for Chemical Admixtures for Concrete.
31. ASTM C595 – Standard Specification for Blended Hydraulic Cements.
32. ASTM C618 – Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
33. ASTM C881/C881M – Standard Specification for Epoxy Resin Base Bonding Systems for Concrete.
34. ASTM C920 – Standard Specification for Elastomeric Joint Sealants.
35. ASTM C928 – Standard Specification for Packaged, Dry, Rapid Hardening Cementitious Materials for Concrete Repairs.
36. ASTM C939 – Standard Test Method for Flow of Grout for Preplaced Aggregate Concrete (Flow Cone Method).
37. ASTM C979 – Standard Specification for Pigments for Integrally

- Colored Concrete.
- 38. ASTM C989 – Standard Specification for Slag Cement for Use in Concrete and Mortars.
 - 39. ASTM C1028 – Standard Test Method for Determining the Static Coefficient of Friction of Ceramic Tile and Other Like Surfaces by the Horizontal Dynamometer Pull Meter Method.
 - 40. ASTM C1059 – Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete.
 - 41. ASTM C1077 – Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation.
 - 42. ASTM C1107 – Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
 - 43. ASTM C1315 – Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.
 - 44. ASTM C1602/C1602M – Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete.
 - 45. ASTM D882 – Standard Test Method for Tensile Properties of Thin Plastic Sheeting.
 - 46. ASTM D1709 – Standard Test Methods for Impact Resistance of Plastic Film by the Free-Falling Dart Method.
 - 47. ASTM D1751 – Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
 - 48. ASTM D2240 – Standard Test Method for Rubber Property – Durometer Hardness.
 - 49. ASTM D4397 – Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications.
 - 50. ASTM E96/E96M – Standard Test Methods for Water Vapor Transmission of Materials.
 - 51. ASTM E154 – Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover.
 - 52. ASTM E329 – Standard Specification for Agencies Engaged in Construction Inspection and/or Testing.
 - 53. ASTM E1155 – Standard Test Method for Determining F_F Floor Flatness and F_L Floor Levelness Numbers.
 - 54. ASTM E1643 – Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs.
 - 55. ASTM E1745 – Standard Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs.
 - 56. ASTM F1249 – Standard Test Method for Water Vapor Transmission Rate Through Plastic Film and Sheeting Using a

- Modulated Infrared Sensor.
- 57. CE CRD-C 572 – Corps of Engineers Specifications for Polyvinyl Chloride (PVC) Waterstop.
 - 58. ISO/IEC/EN 17025 – General Requirements for the Competence of Testing and Calibration Laboratories (formerly ISO/IEC Guide 25-1990 and ASTM E548).
 - 59. NRMCA – Quality Control Checklist – Section 2.
 - 60. NRMCA – Plant Certification Checklist – Section 3.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's descriptive literature and product specification for each product. Include manufacturer's written instructions and installation procedures.
- B. Drawings: Submit concrete pouring plan showing proposed locations of construction and control joints for review by Architect prior to concrete placement.
- C. Samples: Submit product samples when requested by Architect or testing laboratory.
- D. Mockups: Cast architectural concrete panels and integral color concrete panels to demonstrate typical expansion and control joints, integral color, surface finish, tolerances, and standard of workmanship.
 - 1. Construct a freestanding mock-ups demonstrating color, pattern, and finish; minimum four eight by eight feet. Concrete, finishing equipment, and work crew used for the mock-ups shall be the same as that used for the building concrete pour. Mockup shall not be a part of the finished construction.
 - 2. Construct mock-ups to demonstrate aesthetic effects, to set quality standards for materials and execution, and to set quality standards for fabrication and installation.
 - 3. Use products and procedures as intended for final work as performed by experienced applicators specialized in the work of this Section.
 - 4. Accepted mock-ups will serve as the standard of quality by which the work of this Section will be judged.
 - 5. Protect mock-ups from damage. Remove mock-up from site after work of this Section has been completed and accepted.
- E. Quality Assurance/Control Submittals:
 - 1. Certificates:
 - a. Manufacturer's Certification of Compliance that materials (cementitious materials, aggregates, and admixtures) conform to specifications.
 - b. Manufacturer's certificate of compatibility stating that admixtures, slab curing materials, and surface treatments are compatible with subsequent floor finishes and adhesives.
 - 2. Reference Documents: Maintain one copy of ACI SP-15 on site.
 - 3. Concrete mixture proportions and characteristics for each class/type of concrete used.
 - 4. Concrete mixture proportion data for each class/type of concrete used:
 - a. Calculation of required average compressive strength and supporting test records.

- b. Documentation indicating proposed mixture proportions will produce an average compressive strength greater than the required average compressive strength, including field strength test records or trial mixtures.
 - c. Provide documentation in accordance with Concrete Mix Design Submittal Checklist located at the end of this Section.
 - 5. Test Reports.
 - 6. Batch Ticket: Furnish accepted batch tickets at the time of delivery for each concrete load. Indicate on each ticket equipment used for measuring and quantities, by weight, of cement, sand, each class of aggregate, admixtures, and amount of water in the aggregate, water added at the batching plant, and any water withheld at the batch plant. In addition, include mix number, total yield in cubic yards, date and time of day (dispatch time, plant departure time, site arrival time, unloading start and end time).
 - 7. Concrete Placement Record: Keep a record on site including time and date of concrete placing for each portion of the structure for the duration of the project. Record additional information not included in batch ticket such as admixtures added at the job site. Make records available to Architect for review. Submit record to Architect at project completion.
 - 8. Protection of Slabs and Foundations: Submit plans for protection of slabs and foundations, including the following, if applicable:
 - a. Cold Weather Concreting: Comply with submittal requirements of ACI 306.1.
 - b. Hot Weather Concreting: Comply with submittal requirements of ACI 305.1.
- F. Closeout Submittals:
- 1. Concrete placement record.
 - 2. Show location of embedded utilities in record drawings.

1.4 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Concrete Supplier: Firm specializing in products specified in this Section with a minimum five years documented experience; successfully supplying similar materials (design, content, and performance) as specified in this Section.
 - 2. Concrete Batch Plant: Complies with requirements of ASTM C94 and is currently certified per NRMCA Plant Certification Checklist - Section 3 or other certification acceptable to Architect.
 - 3. Contractor's Design Laboratory: Under the direction of civil engineer licensed by the State of California; conforming to ASTM E329 and ASTM C1077.
 - 4. Independent Testing Laboratory: Conforming to ASTM E329, ASTM C1077, and ISO/IEC/EN 17025, acceptable to Architect.
- B. Structural Tests and Inspections: Refer to project Enforcement Agency Structural Tests and Inspection Sheet.

- C. Regulatory Requirements: Conform to requirements of 2016 California Building Code (CBC), Chapter 19, "Concrete", Chapter 17 "Special Inspections and Tests", and as follows:
 - 1. Materials:
 - a. Cementitious Materials: CBC Chapter 19A, Section 1903A "Specifications for Tests and Materials".
 - 2. Inspection: CBC Chapter 17, Section 1705 "Required Special Inspections and Tests" Article 1705.3 "Concrete Construction", as applicable.
- D. Drying Shrinkage Test: Perform per ASTM C157/C157M modified as follows:
 - 1. Prepare 4 inch x 4 inch x 11 inch prisms with an effective gage length of 10 inches fabricated, cured, dried, and measured per ASTM C157/C157M except that specimens shall be removed from molds at an age of 23 hours +/- 1 hour after trial batching, and shall be placed immediately in water at 73 degrees F +/- 3 degrees for at least thirty minutes, and shall be measured within thirty minutes thereafter to determine original length and then submerged in saturated lime water at 73 degrees F +/- 3 degrees.
 - 2. Measurement to determine expansion expressed as a percentage of original length shall be made at seven days. This length at seven days shall be the base length for drying shrinkage calculations. Specimens shall then be stored immediately in a humidity control room, maintained at 73 degrees F +/- three degrees F and fifty percent +/- four percent relative humidity for the remainder of the test.
 - 3. Measurements to determine shrinkage expressed as a percentage of base length shall be made and reported separately for 7, 14, and 21 days of drying after 7 days of moist curing.
- E. Quality Control: Comply with NRMCA Quality Control Checklist – Section 2.
- F. Materials Quality Assurance: Obtain cement and aggregates from same source for the duration of the work unless specifically accepted by Architect.
- G. Pre-Installation Meetings:
 - 1. Conduct pre-installation (pre-pour) meeting in accordance with Division 01.
 - 2. Convene pre-installation (pre-pour) meeting one week prior to commencing work of this Section attended by concrete supplier.
 - 3. Meeting minutes shall be taken and distributed to meeting attendees within three days of meeting.
 - 4. Coordinate work in this Section with work in related Sections.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Comply with requirements of Division 01.
- B. Deliver products in manufacturer's original containers, dry and undamaged, with seals and labels intact.
- C. Store cement and other cementitious materials in weathertight buildings, bins, or silos which exclude moisture and contaminants and keep building materials completely separated.

- D. Arrange and use aggregate stockpiles in a manner to avoid excessive segregation and to prevent contamination with other materials or with other sizes of aggregates. Do not store aggregates directly on ground unless a sacrificial layer is left undisturbed.
- E. Refer to manufacturers' product data sheets for recommended shelf life and storage conditions for admixtures.
- F. Clearly and accurately label materials after containers have been opened.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers:
 - 1. BASF Corporation – Admixture Systems
 - 2. BASF Corporation – Building Systems
 - 3. Grace Construction Products – W. R. Grace & Co.
 - 4. Pecora Corp.
 - 5. Raven Industries Inc.
 - 6. Reef Industries, Inc.
 - 7. Sika Corp.
 - 8. Sika Scofield
 - 9. Stego Industries, LLC.
 - 10. The Euclid Chemical Co.
 - 11. Tremco
 - 12. TXI – Pacific Custom Material, Inc.
 - 13. US Mix Products Co.
 - 14. Vinylex Corp.
 - 15. W. R. Meadows, Inc.
- B. Or accepted equal

2.2 CONCRETE MATERIALS

- A. Cementitious Materials:
 - 1. Cement: ASTM C150, Type II, low alkali (equivalent alkalis ($\text{Na}_2\text{O} + 0.658\text{K}_2\text{O}$) no more than 0.6 percent per ASTM C114), gray.
 - 2. Supplementary Cementitious Materials (SCM):
 - a. Fly Ash: ASTM C618, Class F or Class N. Class C is not permitted.
 - b. Slag Cement: ASTM C989, Grade 100 or Grade 120.
- B. Aggregates: Aggregates used in concrete shall have a combined aggregate distribution similar to the aggregates used in the concrete represented by field test data or used in trial mixtures. Fine and coarse aggregates: ASTM C33. Low-shrinkage producing coarse aggregates per ACI 221R; and uniformly graded as follows:

Sieve Number or Size in Inches	Percent Retained by Weight		
	1-1/2 inch Max.	1 inch Max.	3/4 inch Max.
2 inch	0-5	–	–
1-1/2 inch	0-8	0-5	–
1 inch	8-18	0-8	0-5
3/4 inch	8-18	8-18	0-8
1/2 inch	8-18	8-18	8-18
3/8 inch	8-18	8-18	8-18
No. 4	8-18	8-18	8-18
No. 8	8-18	8-18	8-18
No. 16	8-18	8-18	8-18
No. 30	8-18	8-18	8-18
No. 50	0-18	0-18	0-18
No. 100	0-8	0-8	0-8
No. 200	0-8	0-8	0-8

1. Maximum Nominal Size of Coarse Aggregate: CBC Section 1903A “Specifications for Tests and Materials”, and as follows:
 - a. 1/5 the narrowest dimension between sides of forms,
 - b. 1/3 depth of slab, or
 - c. 3/4 the minimum clear spacing between individual reinforcing bars or wires, or bundles of bars.
2. Lightweight: ASTM C330.
 - a. Acceptable products:
 - 1) Expanded shale as manufactured by TXI – Pacific Custom Material, Inc.
 - 2) Or accepted equal.
3. Aggregate sources shall not contain any alkali-silica reactive material in accordance with ASTM C33, Appendix XI.

C. Water: Potable and complying with ASTM C1602/C1602M.

2.3 ADMIXTURES

- A. General:
 1. Manufacturer certified to contain no more than 0.05 percent water-soluble chloride ions by mass of cementitious material. Admixtures containing calcium chloride or thiocyanates not allowed.
 2. Compatible with other admixtures and cementitious materials in the concrete mix.
 3. Obtain Architect’s written acceptance prior to use of admixtures. Use admixtures according to manufacturer’s written instructions.
- B. Air Entraining Agents: ASTM C260.
 1. Acceptable Products:

- a. MasterAir-AE90, MasterAir AE 200, or MasterAir VR 20 by BASF Corporation – Admixture Systems.
 - b. Darex AEA by Grace Construction Products.
 - c. Eucon Air Mix or Eucon AEA Series by The Euclid Chemical Co.
 - d. Or accepted equal.
- C. Water Reducing:
1. Normal Range: ASTM C494/C494M, Type A.
 - a. Acceptable Products:
 - 1) MasterPozzolith Series by BASF Corporation – Admixture Systems.
 - 2) Eucon Series by The Euclid Chemical Co.
 - 3) WRDA 64 by Grace Construction Products.
 - 4) Plastocrete 161 by Sika Corp.
 - 5) Or accepted equal.
 2. Mid Range Water-Reducing: ASTM C494/C494M, Type A or Type F.
 - a. Acceptable Products:
 - 1) MasterPolyheed Series BASF Corporation – Admixture Systems.
 - 2) Eucon Series by The Euclid Chemical Co.
 - 3) Duracem 55 by Grace Construction Products.
 - 4) Or accepted equal.
 3. High Range Water-Reducing: ASTM C494/C494M, Type F or G.
 - a. Acceptable Products:
 - 1) MasterRheobuild 1000 or MasterGlenium Series by BASF Corporation – Admixture Systems.
 - 2) Eucon Series or Plastol Series by The Euclid Chemical Co.
 - 3) Duracem 100 by Grace Construction Products.
 - 4) Sikament 10 ESL by Sika Corp.
 - 5) Or accepted equal.
- D. Shrinkage Reducing: Reduces dry shrinkage up to 80 percent at 28 days, and up to 50 percent at one year and beyond as tested per ASTM C157/C157M.
1. Acceptable Products:
 - a. MasterLife SRA 20 by BASF Corporation – Admixture Systems.
 - b. Eclipse Floor and Eclipse Plus by Grace Construction Products.
 - c. Eucon SRA Series or Conex by The Euclid Chemical Co.
 - d. Or accepted equal.
- E. Set Retarding: ASTM C494/C494M, Type B or Type D.
1. Acceptable Products:
 - a. Pozzolith Series or MasterSet DELVO Series by BASF Corporation – Admixture Systems.

- b. Eucon Retarder Series, Eucon DS, or Eucon Stasis by The Euclid Chemical Co.
 - c. Or accepted equal.
- F. Set Accelerating: ASTM C494/C494M, Type C or Type E.
- 1. Acceptable Products:
 - a. MasterSet AC 534 or MasterSet FP 20 by BASF Corporation – Admixture Systems.
 - b. Accelguard Series by The Euclid Chemical Co.
 - c. Or accepted equal.
- G. Workability-Retaining: Shall retain concrete workability without affecting time of setting or early-age strength development. ASTM C494/C494M, Type S.
- 1. Acceptable Products:
 - a. MasterSure Z 60 by BASF Corporation – Admixture Systems.
 - b. Plastol AMP Series by The Euclid Chemical Co.
 - c. Or accepted equal.
- H. Integral Color: Furnish color manufacturer with mix design to verify compatibility. Obtain written acceptance of mix design and certification of compatibility. Color admixture and curing compound shall be provided by one manufacturer.
- 1. Color Pigment Materials: ASTM C979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, non-fading, and resistant to lime and other alkalis.
 - 2. Acceptable Manufacturers:
 - a. Sika Scofield. Products:
 - 1) Color Admixture: Chromix P or Chromix ML.
 - 2) Curing Compound: Lithochrome Colorwax.
 - b. BASF Corporation – Admixture Systems. Products:
 - 1) Color Admixture: MasterColor L Series.
 - 2) Curing Compound: MasterKure CC 1315 by BASF Corporation – Building Systems.
 - c. The Euclid Chemical Co. Products:
 - 1) Color Admixture: Colorcrete.
 - 2) Curing Compound: Diamond Clear VOX.
 - d. Davis Colors. Products:
 - 1) Color Admixture: Mix-Ready powdered color additive.
 - 2) Curing Compound: Color Seal II, tinted to match admixture color.
 - e. Conspec Marketing & Manufacturing Co., Inc.; a Dayton Superior Company.
 - f. Substitutions: Under provisions of Division 01.
 - 3. Colors: As selected by Architect from manufacturer's full range of colors.

2.4 CURING MATERIALS AND SLAB TREATMENT

- A. General:
1. Comply with regulations of the California Air Resources Board and the local Air Pollution Control/Air Quality Management District.
 - a. VOC Limit: 350 g/L.
 2. Verify compatibility with subsequent adhesives and coatings before application; furnish Manufacturer's certificate of compatibility. Coordinate with related Sections.
- B. Curing Compound: Select as appropriate for compatibility of subsequent adhesives and coatings.
1. Water-emulsion, dissipating resin based; meets or exceed ASTM C309, Type 1, Class B.
 - a. Acceptable Products:
 - 1) Kurez DR VOX by The Euclid Chemical Co.
 - 2) 1100 by W. R. Meadows, Inc.
 - 3) US SPEC Maxcure Resin Clear by US Mix Products Co.
 - 4) Or accepted equal.
- C. Waterproof Sheet Materials for Curing: ASTM C171 and as follows:
1. Curing paper consisting of two sheets of kraft paper adhered together with a bituminous material with embedded cords or strands of fiber running in both directions not more than 1-1/4 inches apart.
 - a. Tensile strength in machine direction: Thirty foot-pounds per inch of width minimum.
 - b. Tensile strength in cross direction: Fifteen foot-pounds per inch of width minimum.
 2. Polyethylene Film: ASTM D4397; minimum six mil thickness.
 3. White burlap-polyethylene sheeting: Consisting of burlap weighing not less than nine ounces per square yard extrusion coated on one side with at least four mil white opaque polyethylene sheet.
- D. Evaporation Retarder: Water-based polymer concentrate, readily dilutable in water.
1. Acceptable Products:
 - a. MasterKure ER50 by BASF Corporation – Admixture Systems.
 - b. Eucobar by The Euclid Chemical Co.
 - c. US SPEC Monofilm ER by US Mix Products Co.
 - d. Or accepted equal.
- E. Surface Retarder: Water soluble liquid, formulated to retard wet surface of mortar in concrete.
1. Acceptable Products:
 - a. MBT EAC-S Regular or Deep by BASF Corporation – Admixture Systems.
 - b. Sure Etch Series by The Euclid Chemical Co.
 - c. Rugasol-S by Sika Corp.

- d. Or accepted equal.
- F. Concrete Sealer: Chemically reactive, waterborne solution of inorganic silicate or silicate materials; odorless, colorless.
 - 1. Acceptable Products:
 - a. SelectSeal Plus by Sika Scofield.
 - b. MasterKure HD 200 WB by BASF Corporation – Building Systems.
 - c. Eucosil by The Euclid Chemical Co.
 - d. Aqua-Trete SG by Evonik.
 - e. US SPEC Industraseal by US Mix Products Co.
 - f. Or accepted equal.
- G. Vapor Emission Control System: Refer to Section 07 26 50.
- H. Water Repellent: Refer to Section 07 19 19.
- I. Colored Concrete Finishing: Refer to Section 03 35 19.

2.5 GROUTING, BONDING, AND PATCHING MATERIALS

- A. Grout:
 - 1. Non-shrink Grout: ASTM C1107, non-metallic aggregate grout; 7000 psi minimum 28-day compressive strength at fluid water ratio per ASTM C939.
 - a. Acceptable Products:
 - 1) MasterFlow 928 by BASF Corporation – Building Systems.
 - 2) NS Grout, Hi-Flow Grout, or Euco Pre-Cast Grout by The Euclid Chemical Co.
 - 3) US SPEC MP Grout by US Mix Products Co.
 - 4) Or accepted equal.
 - 2. Non-shrink Drypack Grout: Non-shrink, natural aggregates, 7000 psi minimum 28-day compressive strength.
 - a. Acceptable Products:
 - 1) MasterFlow 100 by BASF Corporation – Building Systems.
 - 2) Dry Pack Grout by The Euclid Chemical Co.
 - 3) Sealtight Pac-it by W.R. Meadows, Inc.
 - 4) US SPEC GP Grout by US Mix Products Co.
 - 5) Or accepted equal.
- B. Bonding Materials:
 - 1. Bonding Agent/Admixture:
 - a. Interior or exterior applications: Acrylic or SBR, latex cement bonding agent/admixture; non-re-emulsifiable; meets or exceeds ASTM C1059, Type II.
 - 1) Acceptable Products:
 - a) Akkro-7T, Flex-Con, or SBR Latex by The Euclid Chemical Co.

- b) US SPEC Acrylcoat by US Mix Products Co.
 - c) Sealtight Acry-Lok by W. R. Meadows, Inc.
 - d) Or accepted equal.
 - b. Interior applications or exterior applications not subject to constant water immersions: Ethyl-vinyl acetate (EVA) copolymer liquid bonding agent and admixture; re-emulsifies once and will not re-wet; meets or exceeds ASTM C1059.
 - 1) Acceptable Products:
 - a) Tammsweld by The Euclid Chemical Co.
 - b) US SPEC Multicoat by US Mix Products Co.
 - c) Or accepted equal.
 - 2. Structural Bonding Epoxy Adhesive: Two component, 100 percent solids, 100 percent reactive; meets or exceeds ASTM C881/C881M, Type II, Grade 2, Class B or C as appropriate.
 - a. Acceptable Products:
 - 1) MasterEmaco ADH 1090RS, MasterEmaco ADH 1420, or MasterEmaco ADH 327RS by BASF Corporation – Building Systems.
 - 2) Dural 452 MV by The Euclid Chemical Co.
 - 3) Sealtight Rezi-Weld 1000 by W. R. Meadows, Inc.
 - 4) Or accepted equal.
- C. Self-Leveling Underlayment: Portland cement based, self-leveling 1 inch thick to featheredge. Fast setting – minimum compressive strength 2200 psi after one day; minimum 4000 psi compressive strength at 28 days per ASTM C109.
 - 1. Acceptable Products:
 - a. K-15 Self-Leveling Underlayment Concrete by ARDEX Engineered Cements.
 - b. MasterTop 110 SL by BASF Corporation – Building Systems.
 - c. Flo-Top or EucoFloor SL 160 by The Euclid Chemical Co.
 - d. US SPEC Self-Leveling Underlayment by US Mix Products Co.
 - e. Or accepted equal.
- D. Repair Mortar: Exceeds ASTM C928, R1 and R2; rapid setting – minimum 1300 psi at three hours; 5500 psi at seven days per ASTM C109.
 - 1. Acceptable Products:
 - a. MasterEmaco T 415/430 or MasterEmaco T 1060/1061 Repair Mortars by BASF Corporation – Building Systems.
 - b. Euco-Speed, Versaspeed, or Speedcrete 2028 by The Euclid Chemical Co.
 - c. US SPEC Transpatch by US Mix Products Co.
 - d. Or accepted equal.
- E. Repair Mortar (for patching over steel): Liquid polymer modified, containing an integral corrosion inhibitor, exceeds C928, R2; rapid setting – minimum compressive strength 1500 psi at one day; 3500 psi at seven days; 5000 psi at 28 days per ASTM C109.

1. Acceptable Products:
 - a. MasterEmaco N 350CI with Acrylic Additive or MasterEmaco T 310CI by BASF Corporation – Building Systems.
 - b. Concrete-Top Supreme by The Euclid Chemical Co.
 - c. US SPEC H2 by US Mix Products Co.
 - d. Sikatop 122 Plus by Sika Corp.
 - e. Or accepted equal.
- F. Epoxy Joint Filler: Two component, 100 percent solids, semi-rigid epoxy; hardness: minimum 75 Shore A per ASTM D2240.
 1. Acceptable Products:
 - a. MasterSeal CR 190 by BASF Corporation – Building Systems.
 - b. Euco 700 by The Euclid Chemical Co.
 - c. Sikadur 51 NS by Sika Corp.
 - d. Or accepted equal.

2.6 ACCESSORIES

- A. Cone Hole Plugs: Precast high strength cement compound plugs matching size and shape of form tie cone and matching color of poured-in-place concrete as provided by same manufacturer of form ties.
- B. Capillary Barrier: Clean crushed rock; 3/4 inch nominal maximum size with no material passing a No. 4 sieve.
- C. Expansion Joints:
 1. Joint-Filler Strips: ASTM D1751; bituminous type; preformed, resilient, flexible, and non-extruding.
 - a. Acceptable Product:
 - 1) Sealtight Fiber Expansion Joint by W.R. Meadows, Inc.
 - 2) Or accepted equal.
 2. Self-Leveling Polyurethane Sealant: ASTM C920; Type M; Grade P; Class 25; use T and M.
 - a. Acceptable Products:
 - 1) THC 900/901 by Tremco Inc.,
 - 2) Urexpan NR-200 by Pecora Corp.,
 - 3) MasterSeal SL2 by BASF Building Systems,
 - 4) Or accepted equal.
- D. Anchors, Anchor Bolts, Nuts, and Washers: Refer to Section 05 12 00.

2.7 PRECAST CONCRETE WHEEL STOPS

- A. Provide precast concrete wheel stops, size and shape as indicated on Drawings.
- B. Concrete: Precast, air entrained concrete with a minimum compressive strength of 2,500 psi. Provide chamfered corners and drainage slots on underside and holes for anchoring to substrate.

- C. Dowels: Galvanized steel, 3/4-inch diameter, 10-inch minimum length. Provide where indicated, or as required by design condition.

2.8 CONCRETE MIX

- A. General:
 - 1. Proportion concrete design mixes per ACI 301 Section 4.2.3 and ACI 318 Section 26.4.3.
 - 2. Proportion concrete design mixes per ACI, prepared and tested by an independent testing laboratory acceptable to Architect prior to design mix approval. For each mix design, prepare and perform tests as follows:
 - a. Drying shrinkage test per modified ASTM C157/C157M as specified in this Section; provide at least three test specimens. Drying shrinkage test not required for below grade concrete.
 - 3. Proportioning without field experience or trial mixtures may be permitted with written approval from Architect, where concrete manufacturer can establish the uniformity of its production for concrete of similar type and strength based on recent test data in accordance with ACI 318, Chapter 26, Article 26.4.4 "Documentation of Concrete Mixture Characteristics".
 - 4. Proportion concrete design mix to attain compressive strength as specified below and as needed, with early strength to meet Contractor's work program.
- B. Mix Designs: Refer to Structural Drawings for mix design requirements.
 - 1. Maximum Water Content: 300 pounds per cubic yard.
 - 2. Maximum Drying Shrinkage: 0.048 percent as tested per modified ASTM C157/C157M as specified in this Section after 7 days moist curing plus 21 days drying. This requirement does not apply to below grade concrete.
 - 3. Unless otherwise specified for specific concrete mixes, air entrainment shall be provided for exterior concrete work exposed to freeze-thaw cycles only, such as, site concrete, including pavements, curbs, and gutters.
- C. Admixtures:
 - 1. Use specified admixtures as acceptable to Architect. Verify compatibility of concrete admixtures when using multiple admixtures.
 - 2. Integral Colored Concrete: Add color admixture at batch plant according to manufacturer's written instructions. Mix until color additives are uniformly dispersed throughout mixture. Maintain concrete design mix materials and proportion for color consistency.

2.9 CONCRETE MIXING

- A. Concrete shall be mixed per ACI 304R.

2.10 SOURCE QUALITY CONTROL

- A. Owner shall employ a testing laboratory accepted by Architect to perform the following:
 - 1. Review mix designs and certificates of compliance for materials Contractor proposes to use.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine and verify the following prior to concrete placement.
 - 1. Forms are erected, adequately braced, sealed, lubricated (if required), and bulkhead provided where placing is to stop.
 - 2. Thoroughly water soak wood forms other than plywood at least twelve hours before concrete placement.
 - 3. Steel reinforcement are accurately positioned, securely tied and braced. Verify concrete cover requirements.
 - 4. Coordination with related work is completed.
 - 5. Anchors and embedded items are in position, securely held and braced.
 - 6. Construction joints and previously placed concrete are prepared as specified.
 - 7. Compliance with cold-weather or hot-weather requirements.
 - 8. Compliance with cleaning and preparation requirements.
- B. Report unacceptable conditions to Architect. Begin installation only when unacceptable conditions have been corrected.
- C. Concrete formwork, reinforcement, inserts, and embedded items are subject to Architect's acceptance. Notify Architect at least 48 hours prior to concrete placement.

3.2 PREPARATION

- A. Capillary barrier below interior slabs shall be compacted using one pass of a smooth drum or vibratory roller. Compaction shall be verified by Geotechnical Engineer.
- B. Underslab Vapor Retarder: Install in accordance with manufacturer's written instructions, ASTM E1643, and as specified in this Section.
 - 1. Lay underslab vapor retarder at interior on-ground concrete work.
 - 2. Apply underslab vapor retarder directly on underlying subgrade, base course, or capillary water barrier, unless it consists of crushed material or large granular materials which could puncture the underslab vapor retarder. In this case, choke the surface with a bedding layer of approximately 1/2 inch fine-graded material rolled or compacted over the fill before placing the underslab vapor retarder.
 - 3. Unroll vapor retarder with longest dimension parallel with direction of concrete placement.
 - 4. Lay vapor retarder using the greatest widths and lengths practicable to eliminate joints wherever possible. Lap over footings and seal to foundation walls.
 - 5. Overlap joints 6 inches and seal with compatible seal tape per manufacturer's written recommendations.
 - 6. Seal all penetrations per manufacturer's written instructions using mastic and seal tape. No penetration of underslab vapor retarder is permitted except for reinforcing steel and permanent utilities.
 - 7. Replace torn, punctured, and damaged underslab vapor retarder material prior to placing concrete.
 - 8. Minor repairs may be made by patches of underslab vapor retarder overlapping edges 6 inches and sealing all four sides with tape.
 - 9. Control concrete placement so as to prevent damage to underslab vapor retarder. Screed pins and similar implements that will puncture underslab vapor retarder are not permissible.

- C. Cleaning: Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt and other debris before placing concrete.

3.3 PLACING CONCRETE

- A. Place concrete in accordance with ACI 301 and as specified in this Section.
 - 1. Place and finish Architectural Concrete in the locations indicated on Drawings in accordance with ACI 303.1 and 303R.
 - 2. Concrete construction tolerances shall be per ACI 301 except the top surface of concrete supporting masonry construction shall have a maximum vertical deviation from elevation of +/- 1/2 inch.
- B. Add no water during delivery and at the project site unless specifically accepted by Architect. If water is withheld at batch plant, indicate in delivery ticket the design water for accepted mix, moisture content of aggregates, and free water added at batch plant. If total water added at plant is less than design water to attain slump of accepted mix design, water may be added to concrete at job site, not to exceed the design water content, subject to the limitations specified in ASTM C94/C94M. If additional slump is required, use water reducing admixture.
- C. Discharge mixed concrete within 1-1/2 hours or before mixer has revolved 300 revolutions, whichever comes first, after the introduction of mixing water to the cement and aggregates. Reduce this time to 45 minutes when the concrete temperature exceeds 85 degrees F, unless appropriate measures as specified in ACI 305.1 are taken to maintain slump and temperature of concrete. Slump and concrete temperature can be maintained within limits longer with the use of retarding admixtures or hydration-control admixtures or ice.
- D. Place concrete within fifteen minutes after it has been discharged from the mixer. Handle concrete from mixer to forms in a continuous manner.
- E. Deposit concrete as close as possible to its final position in the forms, with no vertical drop greater than five feet except where suitable equipment is provided to prevent segregation and where specifically authorized.
- F. Deposit concrete continuously or in layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If concrete cannot be placed continuously, provide construction joints as specified. Deposit concrete to avoid segregation.
- G. Deposit concrete in forms in horizontal layers no deeper than 24 inches and in a manner to avoid inclined construction joints. Place each layer while preceding layer is still plastic to avoid cold joints.
- H. Pumping concrete, when specifically accepted, may be conveyed by positive displacement pump such as piston or squeeze pressure type; pneumatic placing equipment is not permitted. Use rigid steel pipe or heavy-duty flexible hose with an inside diameter at least three times the nominal maximum-size coarse aggregate, but not less than 4 inches. Aluminum pipe is not allowed.
- I. Provide adequate scaffolding, ramps and walkways in a manner so that personnel and equipment are not supported by in-place reinforcement.
- J. Consolidation: Consolidate placed concrete with mechanical vibrating equipment per ACI 309R.
 - 1. Consolidate each layer of concrete immediately after placing using internal vibrators, except for slabs 4 inches thick or less.

2. Insert and withdraw vibrators vertically at uniformly spaced location no farther than the visible effectiveness of the vibrator. Hold vibrator stationary and slowly withdraw vertically while operating.
 3. Do not use vibrators to transport concrete inside forms.
 4. Place vibrator to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers that have begun to lose plasticity. Limit vibration duration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mix to segregate.
- K. Concrete Floors and Slabs: Deposit and consolidate concrete for floors and slabs in a continuous operation within limits of construction joints until placement of a panel or section is complete.
1. Consolidate concrete during placement so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
 2. Maintain reinforcement in position on chairs during concrete placement.
 3. Screed slab surfaces with a straightedge and strike off to correct elevations.
 4. Slope exterior surfaces for drainage as directed, unless otherwise shown. Slope interior floors to drains uniformly, where provided.
- L. Hot Weather Concreting: Place concrete according to ACI 305.1 and as follows:
1. Cool components before mixing to maintain concrete temperature below 85 degrees F at time of placement. Chilled mixing water or chopped ice may be used to control temperature. Calculate and include water equivalent of ice in designed water cement ratio.
 2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
 3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.
 4. Protect concrete from surface drying; moisture loss from concrete in plastic state shall be maintained below 0.1 pounds per square foot per hour. Methods may include, but are not limited to: evaporation retardant, sun shades, wind breaks, and fog misting.
- M. Cold Weather Concreting: Place concrete according to ACI 306.1 and as follows:
1. Protect concrete work from physical damage or reduced strength as a result of frost, freezing, or low temperatures.
 2. When ambient temperature is expected to fall below 40 degrees F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 degrees F and not more than 75 degrees F.
 3. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade.
 4. Do not incorporate calcium chloride, salt or other materials containing antifreeze agents into the concrete mix.
 5. Upon Architect's written acceptance and subject to prior approval of mix design, accelerating admixtures, containing no calcium chloride, as specified in this Section may be used.

- N. Do not allow concrete overpour from formwork where underground products and systems need to be installed at or adjacent to the concrete work. If overpour occurs, remove as necessary to accommodate the installation of such items.

3.4 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete, unless otherwise indicated on Drawings.
- B. Construction Joints: Locate and install joints as indicated on Drawings or as accepted by Architect, and in a manner that strength and appearance of concrete are not impaired.
 - 1. Comply with ACI 318, Chapter 26, Article 26.5.6.2.
 - 2. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated.
 - 3. Expose concrete aggregates, a minimum of 1/4 inch depth, creating a rough surface using a surface retardant. Within 24 hours after placing concrete, remove retarded surface mortar using either high pressure water jetting or stiff brushing or a combination of both to expose coarse aggregate. A rough surface of exposed aggregate may also be produced by sandblasting followed by high pressure water jetting.
 - 4. Where new concrete joins existing concrete (concrete more than sixty days old), clean and roughen existing concrete to expose coarse aggregate. Coat with epoxy bonding compound prior to placing new concrete.
 - 5. Install waterstops in the longest lengths practicable where indicated. Use factory fabricated joints; field splices are acceptable in straight sections only.
 - 6. Horizontal joints: Apply a 1 inch wood grade strip, level and straight, 1/2 inch below the placement lift elevation for a neat joint.
- C. Slab-on-Ground Control Joints: Tool or saw-cut weakened plane joints at a depth of at least 1/4 slab thickness where shown on Drawings. Where not indicated in Drawings, provide at distances (in feet) every two times to three times of slab thickness (in inches).
 - 1. Tooled Joint: Form control joints after initial floating by grooving and finishing each joint edge to a 1/8-inch radius. Repeat grooving after applying surface finish.
 - 2. Sawed Joint: Saw cut 1/8-inch width as soon as the concrete has hardened sufficiently to prevent raveling (dislodging of the aggregates) of the edges of the saw cut and completed before shrinkage stresses become sufficient to produce cracking.
 - 3. Fill control joints with epoxy joint filler in accordance with manufacturer's written instructions.
- D. Slab-on-Ground Expansion Joints and Isolation Joints: Provide expansion joints and isolation joints where shown on Drawings, where slab abuts vertical surfaces such as curbs, gutters, and sidewalks.
 - 1. Extend joint-filler strips full width and extend to full depth of joint, terminating not less than 1/2 inch and not more than 1 inch from finish surface. Apply a removable capping flush to slab finish.
 - 2. Install strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.
 - 3. Remove capping when concrete has cured and apply joint sealant.

- E. Dowel Joints: Install dowel sleeves and dowels or dowel bar and support assemblies at joints where shown on Drawings.

3.5 FORMED SURFACES FINISHING

- A. Leave texture imparted on formed concrete surface, unless otherwise specified, except that defective surfaces shall be repaired. Repair defective concrete as specified in this Section.
- B. Maintain uniform color of the concrete, unless painting of surfaces is required, by using only one mixture without changes in material or proportions for any structure or portion of structure exposed to public view.
- C. Repair and patch tie holes. Apply cone hole plugs matching color of cured concrete; and unless otherwise indicated, flush to concrete surface, as provided by form tie manufacturer using waterproof adhesive.

3.6 CONCRETE FLOORS AND SLABS FINISHING

- A. Comply with ACI 302.2R and as specified in this Section. Comply with flatness and levelness tolerance requirements of this Section.
- B. Float Finish:
 - 1. Immediately following placing and consolidating concrete, begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, free of humps or hollows, before excess moisture or bleedwater appears on the surface.
 - 2. When concrete has sufficiently stiffened begin floating to a true and even plane free of ridges. Perform floating using power-driven equipment or hand floats if area is small or inaccessible to power-driven floats.
 - 3. If bleedwater is present prior to finishing, carefully drag-off or remove by absorption with porous materials such as burlap. Dusting of surfaces with dry cement or other materials or the addition of any water during finishing is not permitted.
 - 4. Check slab surfaces with a ten-foot straightedge at regular intervals while concrete is still plastic, to detect high or low areas.
 - 5. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraighten until surface is left with a uniform, smooth, granular texture.
 - 6. Take extreme care during finishing operations to prevent over finishing or to prevent working water into the surface; this can cause crazing (surface shrinkage cracks which appear after hardening) of the surface. Slabs with surfaces exhibiting significant crazing as determined by Architect shall be removed and replaced.
- C. Trowel Finish:
 - 1. After floating is complete and after surface moisture has disappeared, apply trowel finish using a power-driven trowel or hand trowel if area is small or inaccessible to power-driven trowel.
 - 2. Steel trowel to a smooth, even, dense finish, free of blemishes including trowel marks.
 - 3. Apply final steel troweling by hand.
- D. Broom Finish:

1. After floating, lightly trowel surface and then carefully score by pulling a broom across the surface. Use appropriate type of broom to achieve texture specified.
 2. Broom as indicated or as directed by Architect. Where not specifically indicated, broom transverse to traffic or at right angles to the slope of the slab.
 3. Adding water to facilitate brooming is not permitted.
 4. Exterior ramps, walks, and slabs: Apply a slip-resistant finish as follows:
 - a. Where slope is six percent or greater: Heavy broom finish with at least 0.8 coefficient of friction per ASTM C1028.
 - b. Where slope is less than six percent: Medium broom finish with a minimum 0.6 coefficient of friction per ASTM C1028.
- E. Floor and Slab Flatness and Levelness Tolerance: Determine flatness and levelness of floor slabs using the F-Number System in accordance with ASTM E1155 using the inch-pound system of units. Calculate F-Numbers as follows:
1. Definitions:
 - a. Face Flatness Number (F_F): The maximum slab curvature allowed over 24 inches computed on the basis of successive 12 inch elevation differentials.
 - b. Face Levelness Number (F_L): The relative conformity of the slab surface to a horizontal plane as measured over a ten foot distance.
 2. These floor flatness and floor levelness tolerances apply to concrete slabs-on-ground. At raised slabs, only the floor flatness tolerance applies.
 3. Sampling Requirements: As described in ACI 117.
 4. Calculations:
$$F_F = \frac{4.57}{\text{Maximum difference in elevation (in decimals of inches) between successive 12 inch elevation differences.}}$$
$$F_L = \frac{12.5}{\text{Maximum difference in elevation (in decimals of inches) between two points 10 feet apart.}}$$
 5. Tolerances, unless noted otherwise:
 - a. Trowel finish surfaces on ground: F_F 25; F_L 20 (overall tolerance values).
 - b. Float finish surfaces on ground: F_F 20; F_L 17 (overall tolerance values).
 - c. Trowel finish surfaces for concrete fill over steel deck and elevated structural concrete slabs: F_F 25.
 - 1) Depressions in floors between high spots shall not be greater than 5/16 inch below a 10 foot long straight edge.
 - 2) Top of concrete surface elevation shall not vary by more than $\pm 3/4$ inch from the average elevation.
 - d. Minimum local tolerance (1/2 bay or as designated by Architect): 2/3 of specified tolerance values.
 - e. At water closet/lavatory combination units, the floor flatness value shall be F_F 35 (Flat) or better as described in ACI 117 Table R4.8.4.
 6. Refer to Article 3.9 of this Section for remedial work required for out-of-tolerance

concrete.

- F. Site Concrete Flatness Tolerance: 1/4 inch in 10 feet, non-cumulative; unless more restrictive tolerance is indicated or specified. This tolerance does not allow slopes to exceed the specified maximum slopes.
 - 1. Surface cross slopes shall not exceed one unit vertical in fifty units horizontal (two percent).
 - 2. Portland cement concrete paving shall be stable, firm, and slip resistant and shall comply with CBC Section 11B-302 and Section 11B-403.

3.7 CURING AND PROTECTION

- A. Protect freshly placed concrete from premature drying, rapid temperature change, mechanical injury, and injury from flowing water for a curing period not less than seven days. Comply with ACI 306.1 for cold-weather protection and ACI 305R for hot-weather protection during curing.
- B. Curing Methods:
 - 1. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
 - a. If curing compound is applied using a hand held, pump-up sprayer, it shall be back-rolled using a short nap roller.
 - 2. Moist Curing: Keep surfaces in a moist condition for not less than seven days using water saturated absorptive cover (burlap-polyethylene sheeting) kept wet continuously. Cover concrete completely in widest practicable width, with sides and ends lapped at least 12 inches, and sealed with waterproof tape or adhesive. Immediately repair and maintain rips and tears and keep traffic away from surface during curing period.
 - 3. Ponding or Immersion: Continuously immerse concrete throughout the curing period in water not more than twenty degrees below the temperature of the concrete.
 - 4. Integrally Colored Concrete: Apply colored concrete curing compound in accordance with manufacturer's written instructions. Apply curing compound at consistent time for each pour.
- C. Concrete in Forms: Keep forms and exposed concrete surfaces covered and continuously moist. Provide soaker hoses at top of walls or other accepted means of keeping concrete and forms wet while forms remain in place. If forms are removed before end of curing period, continue curing by methods described in this Section.
- D. Floors and Slabs:
 - 1. Evaporation Retarder: Apply evaporation retarder to floors and slabs if hot, dry, or windy conditions cause moisture loss of 0.1 pounds per square foot per hour before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
 - 2. Cure by application of curing and sealing compound or by moist curing. Use appropriate curing method compatible with subsequent floor adhesives and coatings. Moist cure concrete surfaces to receive penetrating liquid floor treatments.

3. Begin curing as soon as free water has disappeared from the concrete surface after placing and final finishing.
- E. Protection:
1. Protect concrete surfaces from damage by tools, equipment, materials, and construction activity.
 2. Traffic, shoring, or loading will not be permitted on concrete surface until it has sufficiently hardened to prevent injury to finish and strength.
 3. Protect all flat work and other surfaces as required with full board of plywood coverings as necessary.

3.8 REMOVAL OF FORMS

- A. Formwork for sides of curbs, beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 degrees F for 48 hours after placing concrete provided concrete is hard enough not to be damaged by form-removal operations and provided curing and protection operations are maintained.
- B. Leave formwork for beam soffits, joists, slabs, and other structural elements that supports weight of concrete in place until concrete has achieved the following:
1. At least one hundred percent of 28-day design compressive strength.
 2. At least seventy percent of 28-day design compressive strength when shores have been arranged to permit removal of forms without loosening or disturbing shores.
 3. Determine compressive strength of in-place concrete by testing representative field or laboratory-cured test specimens according to ACI 301.

3.9 CONCRETE REPAIRS

- A. General: Comply with ACI 301, Article 1.7 as follows:
1. Completed concrete work shall conform to applicable requirements of this Section and Contract Documents.
 2. Concrete work that fails to meet one or more requirements of the Contract Documents but subsequently is repaired to bring the concrete into compliance will be acceptable.
 3. Concrete work that fails to meet one or more requirements of the Contract Documents and cannot be brought into compliance with the Contract Documents is subject to rejection.
 4. Repair rejected concrete work by removing and replacing or by additional construction to strengthen or otherwise satisfy project requirements as directed by Architect. To bring rejected Work into compliance, use repair methods that meet applicable requirements for function, durability, dimensional tolerances, and appearance as determined by Architect.
 5. Submit proposed repair methods, materials, and modifications needed to repair concrete work to meet the requirements of the Contract Documents.
 6. Contractor shall be responsible to bring concrete work into compliance with requirements of Contract Documents.
- B. Defective Concrete: Repair and patch defective concrete work and concrete not conforming to required lines, details, and elevations. Use materials and methods specified in this Section as accepted by Architect. Serious defects, defects affecting

structural strength, or unsatisfactory patching may be cause for complete removal and replacement of concrete.

- C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface stains and other discolorations that cannot be removed by cleaning.
 - 1. Immediately after form removal, cut out honeycomb, rock pockets, and voids more than 1/2 inch in any direction in solid concrete. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with drypack grout before bonding agent has dried. Fill form-tie voids with patching mortar or cone hole plugs secured in place with bonding agent.
 - 2. Repair defects on surfaces exposed to view by blending white Portland cement and standard Portland cement so that, when dry, repair mortar will match surrounding color. Patch a test area at inconspicuous location to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
 - 3. Repair defects on concealed, formed surfaces that affect concrete's durability and structural performance as determined by Architect.

- D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness.
 - 1. Repair defective finished surfaces including spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced section regardless of width, and other objectionable conditions.
 - 2. After concrete has cured fourteen days, correct high spots by grinding.
 - 3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish areas to blend into adjacent concrete.
 - 4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply mortar underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
 - 5. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least 3/4 inch clearance all around. Dampen concrete surface in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mix as original concrete. Place, compact, and finish to blend with adjacent finished concrete.
 - 6. Repair random cracks and single holes 1 inch or less in diameter with drypack grout. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place drypack grout before bonding agent has dried. Compact and finish grouted areas to match adjacent concrete.

- E. Moist cure patches and repairs for at least 72 hours.

- F. Perform concrete structural repairs subject to Architect's acceptance.

3.10 FIELD QUALITY CONTROL

- A. General: Comply with requirements of Division 01.
- B. Testing Service: Owner will select and pay for independent testing agency.
- C. Strength Test Specimen Cylinders: Conduct sampling, curing, and testing per ASTM C172, ASTM C31/C31M, and ASTM C39/C39M. Contractor shall provide moulds required for strength test cylinders. Test samples shall be taken at the point of concrete placement.
 - 1. Frequency: Samples for strength tests of each class of concrete placed each day shall be taken not less than once a day, nor less than once for each 150 cubic yards of concrete, nor less than once for each 5000 square feet of surface area for slabs or walls.
 - 2. A strength test shall be the average of the strengths of at least two 6 inch by 12 inch cylinders or at least three 4 inch by 8 inch cylinders made from the same sample of concrete and tested at the test age designated for the determination of concrete compressive strength.
 - 3. Cylinder Label and Records: Mark and date each test cylinder. Maintain records of test specimen cylinders and send copies to Contractor, Architect, and Owner. Record the following information:
 - a. Cylinder identification mark.
 - b. Date made.
 - c. Concrete supplier.
 - d. Slump/slump flow.
 - e. Specified concrete design strength.
 - f. Pour location and type of structural member.
 - g. Compressive strength test date and age.
 - h. Admixtures added to concrete mix.
 - i. Air content.
 - 4. Compressive Strength Tests: Test laboratory cured specimens at the following ages and report compressive strengths as follows:
 - a. 7 days where early compressive strength is required.
 - b. 28 days.
 - c. 56 days.
 - d. Hold specimens for one strength test in reserve.
 - 5. Test Reports: Furnish copies of test reports directly from testing agency to Contractor, Architect, and Owner.
- D. Slump Test: ASTM C143/C143M. Conduct slump testing when test cylinders are made and additionally for every 150 cubic yards of concrete. Perform additional tests when concrete consistency appears to change. Slump not meeting slump indicated in accepted mix design (\pm one inch) will be rejected. Contractor shall provide slump cones.
- E. Air Content Tests: ASTM C231 for normal weight concrete and ASTM C173/C173M for lightweight concrete. Where air entrainment is specified, conduct air content tests from the first two batches of concrete mixed each day and when test cylinders are made. Concrete not meeting air entrainment requirements shall be rejected and removed.

- F. In the event the cylinders tested do not meet the required concrete design strength, conduct core tests and additional tests or inspections as may be required by Architect to ascertain strength of placed concrete. Costs for additional tests and inspections shall be borne by Contractor.
- G. Floor Flatness/Levelness: Provide verification of Floor and Slab Flatness and Levelness as indicated in Article 3.6.E of this Section. Furnish copies of report directly from testing agency to Contractor, Architect, and Owner.

END OF SECTION

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes: Requirements including but not limited to:
 - 1. Deep penetrating concrete floor sealer.
 - 2. Accessories necessary for a complete installation.

- B. References:
 - 1. California Building Code (CBC):
 - a. Chapter 19A, CBC (2019 edition).
 - 2. American Concrete Institute (ACI):
 - a. ACI 301-16 - Specifications for Structural Concrete.
 - b. ACI 303R-12 - Guide to Cast in Place Architectural Concrete Practice.
 - c. ACI 304R-00 - Guide for Measuring, Mixing, Transporting and Placing Concrete.
 - d. ACI 305R-10 - Hot Weather Concreting.
 - e. ACI 306R-16 - Cold Weather Concreting.
 - f. ACI 308-16 - Standard Practice for Curing Concrete.
 - g. ACI 309R-05 - Guide for Consolidation of Concrete.
 - h. ACI 318-14 - Building Code Requirements for Structural Concrete.
 - 3. American Society of Testing Materials (ASTM):
 - a. ASTM A615/A615M-18e1 Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
 - b. ASTM C33/C33M-18 Standard Specification for Concrete Aggregates.
 - c. ASTM C94 / C94M - 19a Standard Specification for Ready-Mixed Concrete.
 - d. ASTM C114 - 18 Standard Test Methods for Chemical Analysis of Hydraulic Cement.
 - e. ASTM C150/C150M-19a Standard Specification for Portland Cement.
 - f. ASTM C260 / C260M - 10a(2016) Standard Specification for Air-Entraining Admixtures for Concrete.
 - g. ASTM C494 / C494M - 17 Standard Specification for Chemical Admixtures for Concrete.
 - h. ASTM C979 / C979M - 16 Standard Specification for Pigments for Integrally Colored Concrete.
 - 4. American Association of State Highway and Transportation Officials (AASHTO):
 - a. AASHTO M194 – Chemical Admixtures for Concrete.

- C. Regulatory Requirements:
 - 1. Codes:
 - a. Building Code: Comply with applicable requirements for interior finishes in CBC 2019 California Building Code (CCR Title 24, Part 2, as adopted and amended by DSA).
 - 2. Accessibility Requirements: Comply with applicable requirements.
 - a. Americans with Disabilities Act of 1990, as amended.
 - b. ADA Title II Regulations & the 2010 ADA Standards for Accessible Design.
 - c. CBC 2016 California Building Code (CCR Title 24, Part 2, as adopted and amended by DSA).
 - d. CBC Chapter 11B, Access to Public Buildings, Public Accommodations, Commercial Buildings and Public Housing.

1.2 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Provide products produced by a company specializing in production of concrete sealers for minimum of 5 years.

- B. Applicator: Company specializing in concrete floor surface finishing with three years' experience
- C. Furnish concrete hardener, sealer and curing compound in manufacturer's packaging with application instructions

1.3 SUBMITTALS

- A. All submittals shall be made under the provisions of Section 01 33 00 Submittal Procedures. Contractor initial submittal shall include 'Submittal Items' requested below. 'Closeout Submittal Items' shall be provided as required by Section 01 77 00 Closeout Procedures.
- B. Submittal Item No. 03 35 00 A – Product Data
 - 1. Submit product data for all specified products.
- C. Submittal Item No. 03 35 00 B – Installation Instructions
 - 1. Submit manufacturers' instructions for all specified products.
- D. Submittal No. 03 35 00 C - Submit manufacturers' warranty information.

1.4 PROJECT CONDITIONS

- A. Environmental Requirements: Do not proceed with installation until areas to receive work are enclosed and temperature and relative humidity are stabilized and maintained for optimum quality control.
- B. Environmental Limitations: Comply with coating manufacturer's written instructions for substrate temperature, ambient temperature, humidity, ventilation, and conditions affecting floor treatment application. Do not apply coating until wet work in spaces is complete and dry; and overhead work, including installing mechanical systems, lighting, and athletic equipment, is complete.
- C. Apply floor coatings when substrate temperature and surrounding air temperatures are between 50 degrees F and 95 degrees F (10 deg. F and 35 deg. C).
- D. Do not apply floor coatings in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 degrees F (3 degrees C) above the dew point; or to damp or wet surfaces.

1.5 FIELD SAMPLES

- A. Provide field sample under provisions of Section 01 33 00 Submittal Procedures.
- B. Prepare trial finish in area designated by Architect/Engineer

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Concrete Sealer: Deep penetrating sealer, water based, clear, non-yellowing, nontoxic, VOC compliant concrete sealer, integral with concrete through chemical reaction forming nonsoluble seal within pores and capillaries of concrete and sealing it against ingress of moisture while allowing concrete to breathe.
- B. Basis of Design: Euclid Chemical Co. - "Kurez VOX" curing compound with Euclid Chemical

Co. - "Floor Seal VOX" sealer.

- C. Substitutions: Under provisions of Section 01 62 00 Product Options.

2.2 MATERIALS

- A. Curing Compound: ASTM C309, Type 1, Class B; shall be VOC compliant clear curing compound. Typical at all concrete slabs and walks
- B. Sealer: VOC compliant, wear resistant acrylic floor sealer compound, clear color, typical at all exposed interior floor slabs. Do not apply sealer to surfaces to receive stained concrete treatment.
- C. Physical Properties:
1. Permeability: Maximum 0.093 ml/m²/s.
 2. Specific gravity: 1.094.
 3. PH: 11.50.
 4. Flash Point: Nonflammable.
 5. Chemical Identity: Mixture containing silicates, bonding catalysts, and inert materials.

PART 3 EXECUTION

3.1 INSPECTION

- A. Examine substrates for conditions affecting performance and conditions of floor treatment.
- B. Verify compatibility with and suitability of substrates, including existing finishes or primers.
- C. Verify plasticizers in existing concrete substrate will not impair bond.
- D. Proceed with installation after correcting unsatisfactory conditions

3.2 PREPARATION

- A. Clean substrate, removing projections and substances detrimental to the work; comply with recommendations of manufacturer of products to be installed for proper preparation procedures. Mask off or protect adjacent surfaces not scheduled to receive sealer.
- B. Do not use calcium chloride add mixture in concrete

3.3 FLOOR FINISHING

- A. Finish concrete floor surfaces in accordance with ACI 301.
- B. Uniformly spread, screed, and float concrete. Do not use grate tampers or mesh rollers.
- C. Mechanically float surfaces which will receive quarry tile and ceramic tile with full bed setting system.
- D. Steel trowel surfaces to receive carpeting, resilient flooring and seamless flooring.
- E. Light broom finish at concrete walkways.
- F. Steel trowel surfaces which will be left exposed.

3.4 TOLERANCES

- A. Maintain surface flatness as described in Section 03 30 00 Cast-In-Place Concrete.
- B. In areas of floor drains, maintain floor level at walls and slope surface uniformly to drains at 1/8 inch per foot as indicated.

3.5 CURING

- A. Apply curing compound on all horizontal finished surfaces. Apply in accordance with manufacturer's instructions. Do not apply curing compound to surfaces to receive stained concrete treatment.

3.6 TREATMENT

- A. After completion of all interior work, apply second coat of sealer on floor surfaces to be exposed. Apply in accordance with manufacturer's instructions.

END OF SECTION

PART 1 GENERAL

1.1 SUMMARY

- A. This section includes:
1. Chemical stain finishing for cast-in-place concrete with color matched curing and finishing materials; non-slip finish.
- B. References:
1. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only. Refer to Division 01 for definitions, acronyms, and abbreviations.
 2. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
 3. California Building Code (CBC):
 - a. Chapter 19A, CBC (2019 edition)
 4. American Concrete Institute (ACI):
 - a. ACI 301-16 - Specifications for Structural Concrete.
 - b. ACI 303R-12 - Guide to Cast in Place Architectural Concrete Practice.
 - c. ACI 304R-00 - Guide for Measuring, Mixing, Transporting and Placing Concrete.
 - d. ACI 305R-10 - Hot Weather Concreting.
 - e. ACI 306R-16 - Cold Weather Concreting.
 - f. ACI 308-16 - Standard Practice for Curing Concrete.
 - g. ACI 309R-05 - Guide for Consolidation of Concrete.
 - h. ACI 318-14 - Building Code Requirements for Structural Concrete.
 5. American Society of Testing Materials (ASTM):
 - a. ASTM A615/A615M-18e1 Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
 - b. ASTM C33/C33M-18 Standard Specification for Concrete Aggregates.
 - c. ASTM C94 / C94M - 19a Standard Specification for Ready-Mixed Concrete.
 - d. ASTM C114 - 18 Standard Test Methods for Chemical Analysis of Hydraulic Cement.
 - e. ASTM C150/C150M-19a Standard Specification for Portland Cement.
 - f. ASTM C260 / C260M - 10a(2016) Standard Specification for Air-Entraining Admixtures for Concrete.
 - g. ASTM C494 / C494M - 17 Standard Specification for Chemical Admixtures for Concrete.
 - h. ASTM C979 / C979M - 16 Standard Specification for Pigments for Integrally Colored Concrete.
 6. American Association of State Highway and Transportation Officials (AASHTO):
 - a. AASHTO M194 – Chemical Admixtures for Concrete.

1.2 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate manufacturer requirements for preparation of concrete for chemical stain finish with installer of concrete; inform of limitations of materials that might be detrimental to finish.

1.3 SUBMITTALS

- A. All submittals shall be made under the provisions of Section 01 33 00 Submittal Procedures. Contractor initial submittal shall include 'Submittal Items' requested below. 'Closeout Submittal Items' shall be provided as required by Section 01 77 00 Closeout Procedures.

- B. Product Data:
 - 1. Manufacturer's technical data sheets and installation instructions for the following:
 - a. Colored Admixture.
 - b. Curing compound.
 - c. Sealer.
 - d. Acceptable cleaning compounds.
- C. Design Mixes:
 - 1. For each type of integrally colored concrete.
- D. Samples:
 - 1. Submit samples with one surface representative of each required color with each component applied including stain, color matched curing material, sealer, and materials for non-slip finish.
 - a. Manufacturer's color charts showing full range of colors available from both Standard Colors and Custom Colors.

1.4 QUALITY ASSURANCE

- A. Qualification of Installer: Company with minimum five years successful experience in stained cast-in-place concrete finishes similar to finish required for Project.
- B. Mock-Up: Provide at least 100 square foot mock-up of stained finish. Location to be approved by Architect. Accepted mock-up establishes minimum standard of quality and workmanship for colored concrete finish.
- C. Substitutions: The use of any products other than those specified shall be considered providing that the Contractor requests its use in writing within 14 days prior to bid date. This request shall be accompanied by:
 - 1. A certificate of compliance from the material manufacturer stating that the proposed products meet or exceed the requirements specified.
 - 2. Documented proof that the proposed material has a 10 year proven record of performance for staining concrete substrates, confirmed by at least 5 local projects that the Architect and Owner can examine.
- D. Comply with the requirements of ACI 301.
- E. Obtain each specified material from same source and maintain high degree of consistency in workmanship throughout Project.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver the specified products in original, unopened containers with legible manufacturer's identification and information.
- B. Store specified products in conditions recommended by the manufacturer.

1.6 PROJECT CONDITIONS

- A. Environmental Conditions: Maintain an ambient temperature of between 50 deg. F and 90 deg. F during application and at least 48 hours after application.
- B. Protection: Precautions shall be taken to avoid damage or contamination of any surfaces near the work zone. Protect completed stain work from moisture or contamination.

- C. Comply with professional practices described in ACI 305R and ACI 306R.

PART 2 PRODUCTS

2.1 SYSTEMS MANUFACTURERS

- A. L.M. Scofield Co.
- B. Solomon Colors.
- C. Symons Corporation.
- D. Substitutions: Refer to Section 01 62 00 Product Options.

2.2 MATERIALS

- A. Systems Description: Provide chemical stain finish designed specifically for cast-in-place concrete with color matched curing and finishing materials.
 - 1. Materials: Materials for stained concrete finishes shall each come from a single source and shall not be changed throughout Project.
 - 2. Non-Slip Finish: Floor finish to comply with Americans with Disabilities Act (ADA) Standards and California Building Standards Code for non-slip floor finish for persons with disabilities.
 - b. Smooth floor finish required, use of textures not acceptable.
- B. Stain: Chemically reactive, water-solution of metallic salts for coloring cured concrete.
 - 1. Color: As indicated, as selected by Architect from manufacturer's full range of colors where not otherwise indicated.
- C. Color-Matched Curing Material: Manufacturer's standard colored curing material conforming to ASTM C309 - Liquid Membrane Forming Compounds for Curing Concrete.
- D. Clear Sealer: Manufacturer's standard sealer as recommended for specified system.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Site Verification of Conditions: Inspect existing substrates and conditions; beginning application of color materials to concrete signifies acceptance of substrates and conditions. Do not proceed until unsatisfactory conditions have been corrected.
 - 1. Ensure concrete finishing is done in manner to allow for application of specified chemical color finish.

3.2 APPLICATION

- A. Apply chemical coloring and curing materials in process conforming to coloring material manufacturer recommendations and instructions as required to match approved samples and mock-up.
 - 1. Touch-up non-uniform and weak toned areas as necessary to match approved mock-up.
- B. Do not disturb or damage concrete.
- C. Apply and cure colored concrete surfaces under near identical conditions to minimize

appearance blemishes and irregularities beyond those described in manufacturer's literature and approved in mock-up.

- D. Conduct special inspections with Architect and make repairs or replace unsatisfactory work.
- E. Seal concrete with clear sealer after repairs and replaced work is completed.
 - 1. Apply sealer after grouting saw cut joints. Allow to dry for 24 to 48 hours.
 - 2. Apply second coat of Sealcoat.

3.3 PROTECTION

- A. Exclude traffic for at least 14 days after finishing; when construction traffic is permitted, maintain surfaces as clean by removing stains and materials spillage as they occur.

END OF SECTION

PART 1 GENERAL

1.1 DESCRIPTION

- A. This Section describes the requirements for the curing of concrete.

1.2 RELATED WORK

- A. Division 1 – General Requirements
- B. Division 3 - Concrete

1.3 REFERENCES

- A. ACI 301 – Specifications for Structural Concrete Buildings
- B. ASTM C94 – Specifications for Ready-Mixed Concrete
- C. CBC Chapter 19
- D. ASTM C171 –Sheet Materials for Curing Concrete
- E. ASTM C309 – Liquid Membrane-Forming compounds for Curing Concrete
- F. ACI 318 – Building Code Requirements for Structural Concrete

1.4 QUALITY ASSURANCE

- A. Perform Work in accordance with ACI 301 and the California Building Code Part 2, Section 1905.
- B. Obtain materials from the same source throughout the Work.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 9 ounces per sq. yd.
- B. Moisture Retaining Cover: Polyethylene film complying with ASTM C171.
- C. Curing Compound: VOC compliant, clear, with a drying time of 40-minutes, complying with ASTM C309, Type 1, Class B when applied at 200-square feet per gallon.

PART 3 EXECUTION

3.1 CONCRETE CURING AND PROTECTION

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

- B. Curing and Protection: Surfaces not in contact with forms.
1. Curing shall be by application of the specified curing and sealing compound or by application of waterproof sheet materials conforming to ASTM C171.
 2. Liquid membrane-forming curing and sealing compounds shall be applied in accordance with the manufacturer's recommendations and as specified.
 3. Application of sheet materials shall be as specified.
 4. Membrane curing compound used in floor slabs receiving applied finish flooring shall be guaranteed by the manufacturer, in writing, not to impair bonding of adhesive.
 5. For slabs to receive terrazzo, bonded cementitious materials, epoxy or urethane coatings, liquid floor hardener, waterproofing, use a curing treatment of moisture-retaining covers.
 6. Apply curing compound immediately after final finishing.
 7. For curing by waterproof sheet material, the concrete shall be continually moist-cured for a minimum of 7-days. The curing process shall begin immediately after final finishing.
- C. Interior slabs and exterior slabs, sidewalks, and curbs shall be cured with clear curing and sealing compound. Maximum coverage shall be 400-sq. ft. per gal. on steel troweled surfaces and 300-sq. ft. per gal. on floated or broomed surfaces. The curing period shall be continuous for a minimum duration of 7-days when the ambient temperature exceeds 50-deg. F.
- D. Moisture Cover Curing:
1. Cover concrete surfaces with moisture retaining cover conforming to ASTM C171 for curing concrete, placed in the widest possible width, with sides and ends lapped at least 3 inches and sealed by waterproofing tape or adhesive.
 2. Repair holes or tears during curing period using cover material and waterproof tape.
- E. Liquid Membrane Curing:
1. Apply membrane forming curing compound to damp concrete surfaces as soon as possible after final finishing operations are complete, but no later than 2 hours.
 - 2.
 3. Apply uniformly in continuous operation by power spray or rollers in accordance with manufacturer's directions.
 - 4.
 5. Recoat areas which are subjected to heavy rainfall within 3 hours after initial application.
 - 6.
 7. Maintain continuity of coating and repair damage during curing period.
 - 8.
 9. Apply to horizontal surfaces when concrete is dry to touch with power spray or hair broom, in accordance with manufacturer's directions.
 - 10.
 11. Apply to vertical surfaces within 24 hours after forms are stripped in accordance with manufacturer's directions. Do not use where oil form coatings have been used.
- F. Curing Formed Surfaces: Cure formed concrete surfaces, including undersides of beams, supported slabs and similar surfaces by moist curing with forms in place for full curing period or until forms are removed. If forms are removed, continue curing by methods specified above.
- G. Temperature of Concrete During Curing: When atmospheric temperature is 40 deg. F and below, maintain concrete temperature between 50 deg. F and 70 deg. F throughout curing period.
1. When necessary, arrange for heating, covering, insulation or housing required to maintain specified temperature and moisture conditions during the curing period.
 2. When concrete slab placements are subject to high temperatures, wind, and/or low humidity, the Architect may require the use of the evaporation retarder to minimize

plastic cracking. The compound may be required to be applied one or more times during the finishing operations. The initial application shall be made after the strike-off operation.

3. Protect concrete continuously during curing period.
4. Maintain concrete temperature as uniformly as possible, and protect from rapid atmospheric temperature changes. Avoid temperature changes in concrete which exceed 5 deg. F. in one hour, and 50 deg. F. in 24 hour periods.
5. Protect from Mechanical Injury: During curing period, protect concrete from load stresses, heavy shock, excessive vibration, and damage caused by rain or flowing water. Protect finished concrete surfaces from damage by subsequent construction operations.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Concrete masonry units (CMU).
 - 1. Standard.
 - 2. Insulated.
- B. Reinforcement.
- C. Insulation.
- D. Accessory items.

1.2 REFERENCES

- A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only. Refer to Division 01 for definitions, acronyms, and abbreviations.
- B. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- C. Referenced Standards:
 - 1. ACI 315 – Details and Detailing of Concrete Reinforcement.
 - 2. ASTM A951/A951M – Standard Specification for Steel Wire for Masonry Joint Reinforcement.
 - 3. ASTM C5 – Standard Specification for Quicklime for Structural Purposes.
 - 4. ASTM C90 – Standard Specification for Loadbearing Concrete Masonry Units.
 - 5. ASTM C94/C94M – Standard Specification for Ready Mixed Concrete.
 - 6. ASTM C140 – Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.
 - 7. ASTM C144 – Standard Specification for Aggregate for Masonry Mortar.
 - 8. ASTM C207 – Standard Specification for Hydrated Lime for Masonry Purposes.
 - 9. ASTM C270 – Standard Specification for Mortar for Unit Masonry.
 - 10. ASTM C272 – Standard Test Method for Water Absorption of Core Materials for Sandwich Constructions.
 - 11. ASTM C303 – Standard Test Method for Dimensions and Density of Preformed Block and Board-Type Thermal Insulation.
 - 12. ASTM C404 – Standard Specification for Aggregates for Masonry Grout.

13. ASTM C476 – Standard Specification for Grout for Masonry.
14. ASTM C578 – Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
15. ASTM C881 – Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
16. ASTM C1019 – Standard Test Method for Sampling and Testing Grout.
17. ASTM D1056 – Standard Specification for Flexible Cellular Materials Sponge or Expanded Rubber.
18. ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials.
19. TMS 402 – Building Code Requirements for Masonry Structures.
20. TMS 602 – Specification for Masonry Structures.

1.3 SUBMITTALS

- A. Shop Drawings indicating bar sizes, spacings and locations of reinforcing steel, including reinforcing steel at door, window, and utility openings, bending and cutting schedules, supporting and spacing devices, and location/layout and details of each joint type.
- B. Cold-Weather Procedures: Provide Cold-Weather procedures for preventing damage to masonry from freezing before and after placement.
- C. Certified Mix Design for block, grout, and mortar with integral water repellent: Include results of testing or test data when used to establish mix proportions for grout.
- D. Certificate of conformance stating that masonry units meet or exceed applicable ASTM specifications referenced in this Section.
- E. Two samples of each type of masonry unit specified, in selected colors.
 1. Two full size samples of insulated block with insulation inserts.
- F. Two 12 inch long samples of each type of precast concrete cap.

1.4 QUALITY ASSURANCE

- A. Requirements of Regulatory Agencies: The masonry work shall comply with the requirements of this Section and, in addition, shall conform to the applicable requirements of TMS 402 and TMS 602, 2016 California Building Code (CBC), Chapter 17 “Special Inspections and Tests”, Chapter 19 “Concrete”, and Chapter 21 “Masonry”.
 1. Inspection:
 - a. Masonry Construction: Per Section 1705 “Required Special Inspections and Tests”, Article 1705.4 “Masonry Construction”.
 - b. Reinforcing Bar Welding: Per Section 1705, Table 1705.3 “Required Special Inspections and Tests of Concrete Construction”.

- B. Single Source Responsibility for Masonry Units: Obtain masonry units of uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from one manufacturer for each different product required for each continuous surface or visually related surfaces.
- C. Single Source Responsibility for Mortar Materials: Obtain mortar ingredients of uniform quality including color[s] for exposed masonry, from one manufacturer for each cementitious component and from one source and producer for each aggregate. One cement type shall be used for all mortar throughout the project.
- D. Mockup:
 - 1. Mockup shall be constructed and accepted by Architect prior to starting any permanent CMU work.
 - 2. Mockup shall be constructed on the project site at a location to be coordinated with Owner, Architect, and Contractor, and shall be a separate, freestanding sample panel, minimum 6 feet high and 12 feet long, using installation processes and techniques to be used on permanent work, accepted products, and finishes.
 - 3. Mockup shall include the following: Selected CMU colors, finishes, and patterns, bonding, mortar colors, sealant colors, tooled joints, corners, reinforcing, insulation, rake, control, and expansion joints, one window opening, compliance with specified tolerances, and quality of workmanship. Do not grout cells of units. Refer to Drawings for schematic diagram of sample panel.
 - 4. Mockup shall be produced by the workers who will perform the work on the Project.
 - 5. Accepted mockup shall provide a visual quality standard for work and shall remain through completion of the work for use as a quality standard by which subsequent permanent CMU work will be judged. Do not proceed with permanent CMU installation until mockup has been accepted by Architect.
 - 6. Work not meeting the quality standard of the mockup shall be removed and replaced at no cost to the Owner.
 - 7. Maintain mockup undisturbed during construction and dispose of mock-up after all CMU work on project has been completed and accepted.
- E. Pre-Installation Meetings:
 - 1. Convene pre-installation meeting prior to commencing work of this Section.
 - 2. Purpose of meeting is to review the CMU mockup and to discuss workmanship related to mortar placement for head and bed joints and tooling, block alignment, jamb conditions at openings, corner construction, and rake joints for depth and placement.
 - 3. Take minutes of meeting. Distribute to all attendees and concerned parties within five days.

1.5 DEFINITIONS

- A. Grout Lift: The increment of height to which grout is placed into masonry in one continuous operation within a total grout pour.
- B. Grout Pour: The total height of masonry to be grouted prior to the erection of additional masonry. A grout pour consists of one or more grout lifts.

- C. High-Lift Grouting: Grout pour full height of construction between horizontal cold joints using multiple grout lifts.
- D. Low-Lift Grouting: Units laid and grouted to a maximum height of five feet-four inches prior to the erection of additional masonry.

1.6 TESTS AND INSPECTIONS

- A. Tests requested by Architect shall be made by a testing laboratory selected and paid for by Owner. Any masonry work failing to meet required design stresses as specified hereinafter shall be dismantled and replaced at no cost to Owner.
 - 1. Tests requested by Contractor to establish design stresses when tests made by the Testing Laboratory indicate defective masonry shall be paid for by Contractor.
- B. Inspection: Approval of the reinforcing steel after installation must be received from Architect and Special Inspector. Architect and Special Inspector shall be notified at least 48 hours in advance of the beginning of grouting operations.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Unload masonry units carefully and store on raised platform. Masonry units shall be maintained under waterproof cover protected from weather.
- B. Protect cementitious materials against exposure to moisture. Store cementitious materials off the ground, under cover, and in a dry location. Use of cementitious or other materials that have become caked and hardened from absorption of moisture will not be permitted.
- C. Store and protect aggregates where grading and other required characteristics can be maintained.
- D. Store and protect masonry accessories including metal items to prevent deterioration by corrosion and accumulation of dirt.

1.8 JOB AND ENVIRONMENTAL CONDITIONS

- A. Environmental:
 - 1. Cold Weather Conditions: Prevent damage to masonry from freezing before and after placement.
 - 2. Hot Weather Conditions: Protect masonry construction from direct exposure to wind and sun when erected; with an ambient air temperature of 99 degrees F in the shade with relative humidity less than fifty percent.
- B. Do not apply uniform structural loads on CMU construction for at least 12 hours after constructing masonry walls or columns.
- C. Do not apply concentrated structural loads on CMU construction for at least 3 days after constructing masonry walls or columns.
- D. Protect all construction from droppings of mortar.

PART 2 - PRODUCTS

2.1 MANUFACTURERS AND PRODUCTS

- A. Manufacturers, Concrete Masonry Units (CMU):

1. Basalite Block Company, Inc.
 2. Calstone Company
 3. Angelus Block Co., Inc.
- B. Manufacturers and Products, Integral Water Repellent for CMU and Mortar:
1. Grace Construction Products, W. R. Grace & Co. - Conn.; "Dry-Block Block Admixture" for CMU; "Dry-Block Mortar Admixture" for mortar.
 2. ACM Chemistries, Inc.; "RainBloc" for CMU, and "RainBloc for Mortar" for mortar.
 3. BASF Aktiengesellschaft; Rheopel Plus for CMU; Rheopel Mortar Admixture for mortar and grout.
- C. Or accepted equal.

2.2 CONCRETE MASONRY UNITS

- A. Hollow Load Bearing Units: ASTM C90, maximum oven dry density of 135 pounds per cubic foot, 2000 pounds per square inch minimum compressive strength. Provide open and closed-end units, bond beams, U beams, half units and any additional special shapes and sizes as required to complete the Work. Units shall be of the following types:
1. Standard:
 - a. Finishes, sizes, and colors as indicated on Drawings.
 2. Insulated:
 - a. Finishes, sizes, and colors as indicated on Drawings.
- B. Provide integral water repellent admixture in concrete mix during manufacture of concrete masonry units. Mixing and proportions shall be in strict accordance with water repellent manufacturer's printed instructions.

2.3 MORTAR AND GROUT

- A. Portland Cement: ASTM C150, Type I, except use Type III for construction below 40 degrees F. Provide natural color or white cement as required to produce required mortar color. Masonry cement will not be permitted.
- B. Aggregate:
1. For Mortar: ASTM C144.
 2. For Grout: ASTM C404.
- C. Hydrated Lime: Type S, ASTM C207.
- D. Quick Lime: ASTM C5.
- E. Water: Clean and potable, free from impurities detrimental to mortar and grout.
- F. Admixtures:
1. Unless otherwise specified, use admixtures only with Architect's acceptance and without adversely affecting bond or compressive strength.
 2. Grout Additive: Grout pours greater than five feet-four inches shall contain "Grout Aid" by Sika Chemical Corporation or "Pre-Mix Products

Grout Additive” by Valley Abrasive Shot, Inc.

- a. Mix grout additive as recommended by manufacturer.
- G. Provide integral water repellent admixture in mortar mix. Mixing and proportions shall be in strict accordance with water repellent manufacturer’s printed instructions.
- H. Color of mortar as selected by Architect. Anticipate a minimum of three different colors.

2.4 REINFORCEMENT, ACCESSORIES, AND RELATED ITEMS

- A. Steel reinforcement including anchors, ties and accessories: shall conform to CBC Section 2103.4 “Metal Reinforcement and Accessories.”
- B. Reinforcing Steel: Same type and quality specified for concrete reinforcing, Section 03 20 00.
- C. Wire Ties: No. 16 annealed wire for tying reinforcing steel.
- D. Wire Joint Reinforcement: 220 Ladder-Mesh joint reinforcement as manufactured by Hohmann & Barnard, Inc. or accepted equal, with the following characteristics:
 1. Joint reinforcement shall conform to ASTM A951/A951M.
 2. Material: Type 316 stainless steel.
 3. Wire Size: 9 gauge side rods x 9 gauge cross rods, cross welded at 16 inches on center.
 4. First cross rods shall be welded 12 inches from each end to allow lap splices.
- E. Bonding Agent: MasterEmaco ADH 326 two-component 100 percent solids liquid epoxy bonding adhesive in compliance with ASTM C881, Type II, Grade 2, Class C as manufactured by Master Builders Solutions/BASF, or accepted equal.
- F. Control Joints: Closed cell neoprene rubber conforming to ASTM D1056, Grade 2A1. 3/8 inch thick by 3 inches wide. Product: Rapid Expansion Joint DA2015 as manufactured by Dur-O-Wal, a Hohmann & Barnard Company, Hauppauge, NY; 800.645.0616, www.dur-o-wal.com, or accepted equal.
- G. Weep Holes: Where weep holes are required, provide medium density polyethylene plastic tubing in lengths and diameter as indicated on Drawings.
- H. Insulation at Open End Units: Korfil Hi-R-H as manufactured by Concrete Block Insulating Systems, Inc. or accepted equal, with the following characteristics:
 1. Material: Expanded polystyrene, conforming to ASTM C578, Type X for use in 12 inch wide concrete masonry units.
 2. Density: 1.3 pounds per cubic foot minimum per ASTM C303.
 3. Thermal Resistance: R-5 per inch of thickness at 75 degrees F.
 4. Moisture Absorption: Less than 1.0 percent by volume per ASTM C272.
 5. Flame Spread: Less than 5.0 per ASTM E84.
- I. Insulation at Closed End Units, Lintels, Corners: Korfil ICON as manufactured by Concrete Block Insulating Systems, Inc. or accepted equal, with the following characteristics:

1. Material: Expanded polystyrene, conforming to ASTM C578, Type X.
2. Density: 1.3 pounds per cubic foot minimum per ASTM C303.
3. Thermal Resistance: R-5 per inch of thickness at 75 degrees F.
4. Moisture Absorption: Less than 1.0 percent by volume per ASTM C272.
5. Flame Spread: Less than 5.0 per ASTM E84.

2.5 MIXES AND MIXING

A. Mortar:

1. Meet the requirements of CBC Section 2103.2 and ASTM C270 Type S.
 - a. Compressive Strength: 2,000 psi at 28 days.
 - b. Proportions by volume: One part Portland cement, 2.25 parts to 3 parts sand based on damp loose volume, and not less than a quarter and not more than half part lime.
2. Mortar shall be mixed as follows, with a total mixing time not less than ten minutes.
 - a. Place approximately half of required water and sand into mixer while running.
 - b. Add cement and remainder of sand and water into mixer in that order and mix for a period of at least two minutes.
 - c. Add lime and continue mixing as long as needed to secure a uniform mass.
3. Use and place mortar in final position within 2-1/2 hours after mixing. Mortars that have stiffened due to evaporation of water may be re-tempered with water as necessary to restore required consistency during that time period.

B. Grout:

1. Grout shall conform to the requirements of TMS 602 and shall be a coarse grout designed to attain a compressive strength of not less than 2,000 psi at 28 days.
2. Proportions: Grout shall be proportioned as specified by one of the following methods:
 - a. Based on proportions specified in ASTM C476.
 - b. Based on laboratory or field experience with the grout ingredients and the masonry units to be used.
 - 1) For coarse grout, the coarse and fine aggregates shall be combined such that the fine aggregate part is not greater than 80 percent of the total aggregate weight (mass). Coarse grout proportioned by weight shall contain not less than 564 pounds of cementitious material per cubic yard.
 - 2) If this method is selected, Contractor shall submit documented history of grout mix design and results of test data used to establish mix proportions from no less than ten different recent projects.
 - 3) Compressive strength shall be determined in accordance with ASTM C1019.

3. Aggregate for grout shall conform to the requirements set forth in ASTM C404, Aggregates for Grout. Coarse grout shall be used in grout spaces 2 inches or more in width and in all filled-cell masonry construction.
4. Materials for grout shall be measured in suitable calibrated devices. After the addition of water, all materials shall be mixed for at least three minutes in a drum type batch mixer. Mixing equipment and procedures shall produce grout with the uniformity required for concrete by ASTM C94.
5. Grout consistency at time of placement shall enable full grouting of all spaces scheduled to receive grout.

2.6 SOURCE QUALITY CONTROL

- A. Where required by governing code, Owner's Testing Agency will:
 1. Select masonry units by random sampling at the plant and test units for strength, absorption, and moisture content in accordance with ASTM C140; report strengths based on net area.
 2. Review mix designs for mortar and grout.
 3. Review certificates of compliance for materials. Sample and test where non-conformance is suspected.
 4. Perform masonry and grout tests.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive masonry and verify following:
 1. That foundation surface is level to permit bed joint with range of 1/4 inch to 1-1/4 inch.
 2. That edge is true to line to permit protection of masonry to less than 1/4 inch.
 3. That projecting dowels are free from loose scale, dirt, concrete, or other bond-inhibiting substances and properly located.
- B. Do not begin work before unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean concrete surfaces to receive masonry. Remove laitance or other foreign material lodged in surfaces by sandblasting or other means as required.
- B. Ensure masonry units are clean and free from dust, dirt or other foreign materials before laying the units.
- C. Establish lines, levels and coursing. Protect from disturbances.
- D. Provide temporary bracing during erection of masonry work. Maintain in place until masonry has set to provide permanent bracing.
- E. Insulation: Insulation inserts shall be installed in the cores of blocks at the block manufacturer's plant, ready for delivery to the project site. Inserts shall be properly installed in accordance with the insulation manufacturer's installation

instructions to allow blocks to be handled without insert dislodgment. Blocks containing damaged inserts will not be accepted.

3.3 COURSING

- A. Install unit masonry work in accordance with CBC Chapter 21.
- B. Place unit masonry to lines and levels indicated to the following tolerances, as well as tolerances indicated in TMS 602:
 - 1. Variation from unit to adjacent unit: 3/16 inch maximum.
 - 2. Variation from plane to wall: $\pm 1/4$ inch in 10 feet; $\pm 3/8$ inch in 20 feet; $\pm 1/2$ inch maximum.
 - 3. Variation from plumb: $\pm 1/4$ inch in 10 feet; $\pm 3/8$ inch in 20 feet; $\pm 1/2$ inch maximum.
 - 4. Variation of level coursing: 1/4 inch in 10 feet; 1/2 inch maximum.
 - 5. Variation of joint thickness: $\pm 1/8$ inch.
- C. Bond:
 - 1. Use running bond typical unless otherwise noted. Lay concrete masonry units with vertical joints located at center of unit in course below.
 - 2. Use stack bond where noted or indicated on Drawings. Lay concrete masonry units with vertical joints aligned with joints in course below. Where stack bond is used, all concrete masonry units shall be double open-end units so that all head joints are made solid. All units shall be bond beam units to facilitate the flow of grout.
- D. Maintain masonry courses to uniform width. Make vertical and horizontal joints equal and of uniform thickness.
- E. Preserve the vertical continuity of cells in concrete unit masonry. The minimum clear horizontal dimensions of vertical cores shall be 3 inches by 3 inches for an 8-inch wide block.

3.4 PLACING AND BONDING

- A. Do not install concrete masonry units which are wet, cracked, broken or chipped beyond ASTM C90 finish and appearance tolerances.
- B. Lay only dry concrete masonry units.
- C. Perform jobsite cutting with proper tools to provide straight unchipped edges. Take care to prevent breaking masonry unit corners or edges.
- D. Lay units with bed and head joints filled from the faces of the units to a distance in not less than the thickness of the face shell.
 - 1. Webs shall be fully mortared in all courses of piers, columns, and pilasters, and when necessary to confine grout or insulation.
 - 2. Vertical cells to be grouted shall be aligned and have unobstructed openings for grout.
 - 3. Buttering of joint corners and deep or excessive furrowing of mortar joints is not permitted.
- E. Keep cavity airspace and weep holes clean of mortar. Clean out promptly if mortar falls into cavity airspace or plugs weep holes.

- F. In-Progress Cleaning:
 - 1. Remove excess mortar.
 - 2. Dry brush exposed masonry prior to the end of each workday.
 - 3. Protect wall from mud splatter and mortar droppings.
 - a. Set scaffolds and scaffold boards so that mortar is not deflected onto masonry.
 - b. At the end of each workday, turn scaffold boards so that rainwater is not deflected onto masonry.
 - 4. Place concrete masonry units such that mortar does not run down the face of the wall or smear the masonry face.
- G. Adjustments:
 - 1. Do not shift or tap concrete masonry units after mortar has taken initial set.
 - 2. If adjustment is required, remove unit and mortar in its entirety and replace.
- H. After joints are tooled, cut off mortar tailings with trowel and dry brush excess mortar burrs and dust from the face of the masonry.
- I. Fully bond interior and exterior corners and properly anchor intersecting walls.

3.5 JOINTS

- A. Horizontal and vertical joints at masonry units shall be as specified herein and concrete unit masonry construction shall be 3/8-inch wide and as follows:
 - 1. Point joint tight in masonry below ground.
 - 2. All end joints shall be fully filled with mortar and joints squeezed tight. Slushing of mortar into joints shall not be permitted. Mortar in bed joints shall be held back approximately 1/2 inch from cell to provide positive bond with grout.
 - 3. Exposed Joints:
 - a. At all interior exposed surfaces of concrete masonry units, vertical and horizontal joints shall be concave.
 - b. At all exterior and interior surfaces to receive adhered, surface applied coverings/finishes, vertical and horizontal joints shall be flush.
 - c. At all exterior surfaces of concrete masonry units, vertical and horizontal joints shall be concave.
 - 4. Tool vertical joints first.
 - 5. Concave joints shall be formed by striking the mortar flush, and after partial set tooled with a tool of sufficient length to provide a uniform joint, free of waves. Tool shall be of a diameter to provide a joint that is as close to flush as possible. Use tool with large enough radius that joint is not raked free of mortar.

3.6 MASONRY REINFORCEMENT

- A. Place reinforcement in accordance with ACI 315, to the tolerance specified in Drawings.

- B. Reinforcing steel shall not be bent or straightened in a manner that will injure the material. Bars with kinks or bends not shown on the plans shall not be used. Heating of bars for bending will not be permitted.
 - 1. Bars shall conform accurately to the sizes, shapes, lines and dimensions shown on Drawings and with hooks and bends made as detailed. Bars shall be placed as indicated on Drawings and centered on grout space.
 - 2. At the time grout is placed around it, reinforcing steel shall be clean of mill scale or other coatings that will destroy or reduce bond.
 - 3. All vertical reinforcing steel shall be installed in one piece, full height of wall, and braced throughout its height in a manner that will retain the steel in proper position and provide the proper clearance.

3.7 GROUTING

- A. General Requirements:
 - 1. All cells shall be grouted solid.
 - 2. Use grout pump, hopper or bucket to place grout.
 - 3. Place grout in final position within 1-1/2 hours after introduction of mixing water.
 - a. Place grout and rod with a 3/4-inch flexible cable vibrator sufficiently to cause it to flow into all voids between the cells and around the reinforcing steel. Slushing with mortar will not be permitted.
 - b. Do not insert vibrators into lower pours that are in a semi-solidified state.
 - 4. Stop grout approximately 1-1/2 inches below top of last course; except at top course bring grout to top of wall. Where bond beams occur, stop grout pour a minimum of 1/2 inch below the top of the masonry.
 - 5. Prior to grouting, the grout space shall be cleaned so that all spaces to be filled with grout do not contain mortar projections greater than 1/2 inch, mortar droppings or other foreign material.
 - 6. The grouting of any section of wall shall be completed in one day with no interruptions greater than one hour.
- B. High-Lift Grouting:
 - 1. Due to the anticipated congestion of conduits, pipes, reinforcing bars, etc., hollow metal framed openings with security requirements for fully grouted frames, concerns of full grout consolidation below window openings, and increased risk of frame movement during grouting, low-lift grouting shall be employed.
 - 2. For bidding purposes, high-lift grouting shall not be anticipated. High-lift grouting may be considered at select locations only when specifically reviewed and accepted by Architect.
 - 3. Where select wall areas are accepted to utilize high-lift grouting, the method shall be acceptable to the Architect and the Authority Having Jurisdiction.
 - a. Maximum grout pour height, comprised of multiple 5 feet-4 inch maximum grout lifts:

- 1) 12 feet-8 inches for 8 inch wide and 12 inch wide insulated CMU.
 - 2) 24 feet-0 inches for 12 inch wide CMU.
4. Cleanouts are required when high-lift grouting method is used. Cleanouts shall be provided in the bottom course at every vertical rebar. Cleanouts shall be located on concealed faces of wall and shall be sealed after inspection and before grouting. Cleanouts will not be allowed on exposed faces of wall.
- C. Low-Lift Grouting:
1. Units shall be laid to a maximum height of five feet-four inches before grouting, and all over-hanging mortar and mortar droppings shall be removed.
 2. Grouting shall follow each five feet-four inches height of construction laid, and shall be consolidated so as to completely fill all voids and embed all reinforcing steel.

3.8 CONTROL JOINTS

- A. Install resilient control joints in continuous lengths as shown on Drawings.
- B. Size joints in accordance with manufacturer's recommendations for sealant performance.
- C. Install backer rod and sealant under provisions of Section 07 92 00.
- D. Install preformed control joint filler at locations indicated on drawings.
- E. Use proper size material to create sealant joint specs.

3.9 EXPANSION JOINTS

- A. Install expansion joint filler material on centerline of wall at locations indicated on Drawings.
- B. Install backer rod and sealant under provisions of Section 07 92 00.

3.10 BOND BEAMS

- A. Bond beams shall be located where shown and detailed on Drawings, and shall be reinforced as indicated and as hereinafter specified.

3.11 BUILT-IN WORK

- A. Miscellaneous Embedded Items: All items indicated to be embedded in masonry shall be carefully located and anchored to prevent movement during grouting operations. Avoid cutting and patching.
 1. Install all anchor bolts and anchors furnished under other Sections.
- B. Pipes and Conduits: Horizontal and vertical pipes and conduits embedded in walls shall not exceed the limitations indicated on the Structural Drawings.

3.12 CUTTING AND FITTING

- A. Cutting: Make all unit cuts, including those for bonding, holes, boxes, etc., with motor-driven masonry saws, using either an abrasive or diamond blade. Cut

neatly and locate for best appearance. Cut with proper tools to provide straight, unchipped edges and take care to prevent raking masonry unit corners or edges.

- B. Cut and fit for weep holes pipes and miscellaneous penetrations. Cooperate with other sections' work to provide correct size, shape and location.
- C. Obtain approval prior to cutting or fitting any area not indicated or where appearance or strength of masonry work may be impaired.

3.13 REPAIR, POINTING AND CLEANING

- A. Remove and replace masonry units which are loose, chipped, broken, stained or otherwise damaged, or if units do not match adjoining units.
- B. Pointing: During the tooling of joints, enlarge any voids or holes and completely fill with mortar.
- C. Dry brush masonry surface after mortar has set, at end of each day's work and after final pointing.
- D. Leave work and surrounding surface clean and free of mortar spots and droppings.
- E. Cleaning:
 - 1. Keep walls clean daily during installation using brushes, rags, and burlap squares. Do not allow excess mortar lumps or smears to harden on the finished surfaces. Remove green mortar with burlap or a dry cloth.
 - 2. Upon completion of masonry installation, repair all holes. Mortar joints that are not properly tooled or that show cracks shall be cut out, removed, and repointed at no cost to the Owner.
- F. Final Cleaning:
 - 1. Just prior to project substantial completion, and prior to the application of water repellent/anti-graffiti coating, clean masonry surfaces.
 - a. Cleaning Product: PROSOCO Sure Klean line of cleaners, product appropriate to installed concrete units, or accepted equal.
 - 1) Run-off from cleaning operations shall be contained, neutralized, and disposed of per State and local regulations. Obtain necessary permits for disposal of run-off.
 - b. Sandblasting is an acceptable alternative means of cleaning, provided that no silica particulates are used.
 - 1) Sandblasting operations shall not generate large quantities of dust. Employ wet sandblasting methods to control dust.
 - 2. Final cleaning and water repellent/anti-graffiti coating application shall not be scheduled until walls have thoroughly dried out and sealants have been installed and cured.

3.14 FIELD QUALITY CONTROL

- A. Owner's Inspector and/or Testing Agency will:

1. Provide the following checks as a minimum:
 - a. Measurement and mixing of field mixed mortar and grout.
 - b. Moisture conditions of masonry units at time of laying.
 - c. Inspection of laying of units with special attention to joints and bonding of units at corners.
 - d. Proper placement of reinforcement including splices, clearances and supports.
 - e. Observation of placement of pipes, conduits, or other weakening elements.
 - f. Inspection of grout spaces immediately prior to grouting for removal of mortar fins, dirt and debris.
 - g. Continuous inspection of grout placement with attention to procedures to avoid segregation and achieve proper consolidation.
 - h. Perform or supervise sampling for testing.
- B. Contractor shall be responsible for repair of any damage to work caused by testing.
- C. Contractor shall pay Owner's Testing Agency for all additional testing required, including masonry cores, when laboratory tests of specimens show compressive strengths below specified minimum and judged to be inadequate by Architect.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Structural steel framing and support members.
- B. Base plates and bearing plates.
- C. Grouting under base plates.

1.2 REFERENCES

- A. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.

B. Referenced Standards:

- 1. AISC 303-05 – Code of Standard Practice for Steel Buildings and Bridges.
- 2. ANSI B18.22.1 – Plain Washers.
- 3. ANSI B18.23.1 – Beveled Washers.
- 4. ASTM A6/A6M – Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling.
- 5. ASTM A36/A36M – Standard Specification for Carbon Structural Steel.
- 6. ASTM A53/A53M – Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
- 7. ASTM A108 – Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
- 8. ASTM A123/A123M – Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- 9. ASTM A307 – Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
- 10. ASTM A325 – Standard Specification for Structural Bolts, Steel, Heat-Treated, 120/105 ksi Minimum Tensile Strength.
- 11. ASTM A490 – Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength.
- 12. ASTM A500 – Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
- 13. ASTM A563 – Standard Specification for Carbon and Alloy Steel Nuts.
- 14. ASTM A572/A572M – Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.

15. ASTM A780/A780M – Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
16. ASTM A992 – Standard Specification for Structural Steel Shapes.
17. ASTM F436 – Standard Specification for Hardened Steel Washers.
18. ASTM F844 – Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use.
19. ASTM F959 – Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners.
20. ASTM F1554 – Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.
21. ASTM F1852 – Standard Specification for “Twist Off” Type Tension Control Structural Bolt/Nut/Washer Assemblies, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
22. AWS A2.4 – Standard Symbols for Welding, Brazing, and Nondestructive Examination.
23. AWS D1.1 – Structural Welding Code – Steel.
24. AWS D1.4 – Structural Welding Code – Reinforcing Steel.
25. AWS D1.8 – Structural Welding Code – Seismic Supplement.
26. AWS D2.0 – Specifications for Welded Highway and Railway Bridges.
27. RCSC – Specification for Structural Joints Using High Strength Bolts.
28. SSPC – Steel Structures Painting Manual, Volumes 1 and 2.

1.3 SUBMITTALS

- A. Shop Drawings:
 1. Indicate profiles, sizes, spacing, and locations of structural members, attachments, fasteners, and required connections, including connections not detailed on Drawings.
 2. Indicate welded connections with AWS A2.4 welding symbols. Indicate net weld lengths.
 3. Clearly distinguish between shop and field bolts and welds.
- B. Manufacturer's Mill Certificate: Submit Manufacturer's Certificates under provisions of Division 01, certifying that steel, fasteners and welding electrodes meet or exceed specified requirements.
- C. Mill Test Reports: Submit Manufacturer's Reports under provisions of Division 01, indicating structural strength, destructive and non-destructive test analysis and ladle analysis.
- D. Submit product data for type of metal primer proposed for use.

- E. Welders' Certificates: Submit certificates under provisions of Division 01, certifying welders employed on the Work, verifying AWS qualifications within the previous twelve months.
 - 1. Welders who have not performed welding for period of three or more months shall be requalified.
 - 2. Welders whose work fails to pass inspection shall be requalified before performing further welding.
 - 3. Contractor shall pay costs of certifying qualifications.
- F. Welding Procedures: Submit proposed Welding Procedure Specifications (WPS). Where WPS is not prequalified by AWS D1.1, submit supporting Performance Qualification Records (PQR).
- G. Qualification Data: For qualified Fabricator and Installer.

1.4 DEFINITIONS

- A. Structural Steel: Elements of structural-steel frame, as classified by AISC 303-05, Code of Standard Practice for Steel Buildings and Bridges.
- B. Seismic-Force-Resisting System: Elements of structural-steel frame designated as "SFRS" or along grid lines designated as "SFRS" on Drawings, including columns, beams, and braces and their connection.

1.5 QUALITY ASSURANCE

- A. Fabricate structural steel members in accordance with the AISC Specification for Structural Steel Buildings, Code of Standard Practice for Steel Buildings and Bridges and Quality Criteria and Inspection Standards.
- B. Fabricator Qualifications: Company specializing in performing the work of this Section with sufficient documented experience.
- C. Installer (Erector) Qualifications: Company specializing in performing the work of this Section.

1.6 REGULATORY REQUIREMENTS

- A. Conform to 2016 California Building Code (CBC), Chapter 16 "Structural Design", Chapter 22 "Steel", and Chapter 17 "Special Inspections and Tests".
- B. Structural Tests and Inspections: Refer to project Enforcement Agency Structural Tests and Inspection Sheet.
- C. Materials:
 - 1. Material identification per CBC Chapter 22, Section 2203, Paragraph 2203.1 "Identification".
 - 2. Protection of structural steel per CBC Chapter 22, Section 2203, Paragraph 2203.2 "Protection".

1.7 FIELD MEASUREMENTS

- A. Verify that field measurements are as shown on shop drawings.

- B. Coordinate fabrication and delivery of structural steel items with concrete work and with all other trades to permit such items to be built into the structure without delay.

1.8 DELIVERY, STORAGE AND HANDLING

- A. Delivery of Materials to be Installed Under Other Sections: Anchor bolts and other anchorage devices which are embedded in cast-in-place concrete construction shall be delivered to the project site in time to be installed before start of cast-in-place concrete operations.
- B. Storage of Materials:
 - 1. Structural steel members to be stored at the Project site shall be placed above ground, on platforms, skids or other supports.
 - 2. Steel shall be protected from corrosion.
 - 3. Other materials shall be stored in a watertight, dry place until ready for installation in the Work.
 - 4. Packaged materials shall be stored in their original package or container.
 - 5. Do not store materials on the structure in a manner that might cause distortion or damage to members of supporting structures. Repair or replace damaged materials or structure as directed by Architect.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Structural Steel Members:
 - 1. ASTM A992 Grade 50 for wide flange and WT shapes.
 - 2. ASTM A36/A36M or A572 Grade 50 for plates, as noted on Drawings.
 - 3. ASTM A36/A36M for channels, angles and all other shapes.
- B. HSS:
 - 1. Tubing: ASTM A500, Grade C.
 - 2. Round: ASTM A500, Grade C.
- C. Pipe: ASTM A53/A53M, Type E or S, Grade B.
- D. Bolts and Nuts: ASTM A307, Grade A, with ASTM A563, Grade A, hex nuts; ASTM A325N, Type 1, with ASTM A563, Grade C, heavy hex nuts; anchor bolts, ASTM F1554, grade as indicated on Drawings.
- E. High-Strength Bolts, Nuts, and Washers: ASTM A325, Type 1, heavy hex steel structural bolts; ASTM A563 heavy hex carbon-steel nuts.
- F. High-Strength Bolts, Nuts, and Washers: ASTM A490, Type 1, heavy hex steel structural bolts or tension-control, bolt-nut-washer assemblies with splined ends; ASTM A563 heavy hex carbon-steel nuts; and ASTM F436 hardened carbon-steel washers, plain.
- G. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F1852, Type 1, heavy hex head or round head steel structural bolts with splined ends; ASTM A563 heavy hex carbon-steel nuts; and ASTM F436 hardened carbon-steel washers.

- H. Welding Materials:
 - 1. Typical Weld Locations: AWS D1.1; type required for materials being welded.
 - 2. SFRS and Demand Critical Welds: AWS D1.8; filler metal shall be classified as low hydrogen and shall have a minimum Charpy V-notch toughness of twenty foot-pounds at 0 degrees F for SFRS welds and forty foot-pounds at 70 degrees F for Demand Critical Welds as determined by AWS classification or manufacturer certification. Demand critical weld material shall also meet heat input testing requirements of AWS D1.8, Clause 6.3.
- I. Circular washers for common bolts: ASTM F844, Type A, and ANSI B18.22.1.
- J. Beveled washers for common bolts: ANSI B18.23.1.
- K. Washers for high strength bolts: Direct tension indicator. ASTM F959 hardened circular, beveled and clipped, ASTM F436.
- L. Post-Installed Concrete Anchors: I.C.C. approved, as indicated and manufactured by Hilti or accepted equal.
- M. Welded Headed Stud Anchors: ASTM A108. Welding, testing and inspection shall be in accordance with AWS D1.1.
- N. Steel Shop and Touch-Up Primer: TNEMEC Series 115 Uni-Bond DF or accepted equal.
- O. Shop and Touch-Up Zinc Rich Primer for Galvanized Surfaces: ZRC Galvillite Galvanizing Repair Compound as manufactured by ZRC Worldwide Company, Phone: (800) 831-3275, or accepted equal.
- P. Weld filler material: All weld filler material shall have a minimum tensile strength of 70 KSI per AWS D1.1, latest edition approved by code enforcement agency.
- Q. Drypack: Refer to Section 03 30 00.
- R. Grout: Non-shrink type, pre-mixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing additives, capable of developing a minimum compressive strength of 7,000 psi at 28 days.
- S. Reinforcing Steel: Refer to Section 03 20 00.

2.2 FABRICATION

- A. General: Fabricate items of structural steel in accordance with AISC specifications and as indicated on Drawings. Properly mark and match-mark all materials for field assembly. Fabricate for delivery sequence which will expedite erection and minimize field handling.
 - 1. Welded splicing of structural members may be done only upon written acceptance by Architect, unless otherwise indicated on Drawings. Splicing shall be thoroughly examined by a nondestructive means at Contractor's expense. Inspection shall be made by a recognized and approved testing laboratory; procedure, technique and standards of acceptance shall conform to Appendix E of AWS Standard D2.0-69. Correct faulty welds and re-examine in a manner specified for original welds.

- B. Welded Construction:
 - 1. Weld in accordance with AISC using manual shielded arc method or flux cored arc method in accordance with AWS D1.1 and AWS D1.8. Groove welds shall be complete joint penetration welds, unless specifically designated otherwise on Drawings.
 - 2. Remove back-up plates for complete joint penetration welds when specifically requested by testing laboratory to perform non-destructive testing. Remove at no cost to Owner.
 - 3. Weld reinforcing steel in accordance with AWS D1.4 and using prequalified procedures.
- C. Connections:
 - 1. Weld or bolt shop connections as indicated.
 - 2. Bolt field connections except where welded or other connections are indicated. Provide unfinished threaded fasteners only where noted on Drawings and for temporary bracing to facilitate erections.
- D. Holes for Other Work: Provide holes required for securing other work to structural steel framing, and for the passage of work through steel framing members as indicated. Provide threaded nuts welded to framing, and other specialty items as shown to receive other work. Cut, drill or punch holes perpendicular to metal surfaces. Thermally cut holes are only permitted at anchor rod holes.

2.3 FINISHES

- A. Prepare structural component surfaces in accordance with SSPC SP-2 at concealed locations and SSPC SP-6 at exposed locations. Provide Class "A" (clean mill scale) contact surfaces per RCSC 2009 at high-strength bolted connections.
- B. Do not prime surfaces in direct contact with concrete, where field welding is required, or contact surfaces of steel-to-steel connections. Provide Class "A" or better contact surfaces at steel connections per RCSC Specification for Structural Joints Using High Strength Bolts, latest edition.
- C. All exposed interior steel shall be primed with shop primer unless otherwise noted.
 - 1. Primer shall be applied in one coat, to meet or exceed the minimum mil thickness required by the primer manufacturer.
- D. All un-exposed, concealed or enclosed interior or exterior steel shall be primed with shop primer unless otherwise noted.
 - 1. Primer shall be applied in one coat, to meet or exceed the minimum mil thickness required by the primer manufacturer.
- E. All exposed exterior steel shall be galvanized unless otherwise noted.
 - 1. Galvanize to G120 in accordance with ASTM A123/A123M, designated steel items.
 - 2. At galvanized members, touch-up all welds with zinc-rich primer.
- F. Column Bases: Column bases and base plates shall be finished in accordance with the following requirements:
 - 1. Steel bearing plates 2 inches or less in thickness are permitted without

milling provided a smooth and notch-free contact bearing surface is obtained. Steel bearing plates over 2 inches but not over 4 inches in thickness are permitted to be straightened by pressing or, if presses are not available, by milling for bearing surfaces, except as stipulated in subparagraphs (2) and (3) below, to obtain a smooth and notch-free contact bearing surface. Steel bearing plates over 4 inches in thickness shall be milled for bearing surfaces, except as stipulated in subparagraphs (2) and (3) below.

2. Bottom surfaces of bearing plates and column bases that are grouted to ensure full bearing contact on foundations need not be milled.
3. Top surfaces of bearing plates need not be milled when complete-joint-penetration groove welds are provided between the column and the bearing plate.

2.4 TESTING AND INSPECTION

- A. General: Owner will engage and pay a testing agency to perform the following services:
 1. Review manufacturer's certificates and check heat numbers and that the steel is properly identified in accordance with CBC Section 2203 "Identification and Protection of Steel for Structural Purposes".
 2. Testing of unidentified materials or as directed by Owner.
 3. Provide inspection per CBC Sections 1705.2 and 1705.12.
 4. In the event an examination discloses faulty welds and additional tests are required to fully examine the welds, the cost of the additional tests shall be paid for by Owner and back-charged to Contractor.
 5. All defective welds shall be repaired and tested at no expense to Owner.
 6. Perform any physical tests of structural steel as required by Architect. Perform ultrasonic tests on members as determined by Architect to determine if delamination defects in steel members are evident.
 7. High-strength bolting testing and inspection shall conform to the following requirements:
 - a. Perform pre-installation verification of pretensioned bolts per RCSC Section 7.1 for the selected pretensioning method.
 - b. Inspect bolted joints per RCSC Section 9 and CBC Section 1705.2.1.
 - c. All fasteners failing to meet the specified tension shall be examined to determine the cause of failure and re-tested.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that field conditions are acceptable and are ready to receive work.
- B. Beginning of installation means erector accepts existing conditions.
- C. Bolts shall be clean and free of grease, oil and all other deleterious substances.

3.2 ERECTION

- A. Allow for erection loads and for sufficient temporary bracing to maintain structure safe, plumb and in true alignment until completion of erection and installation of permanent bracing.
- B. Field weld components indicated on shop drawings.
- C. Do not field cut or alter structural members without acceptance of Architect.
- D. After erection, prime welds, abrasions and surfaces not shop primed, except surfaces to be in contact with concrete.
- E. Setting Base Plates:
 - 1. Clean concrete bearing surfaces and roughen to improve bond. Clean the bottom surface of base plates.
 - 2. Set loose and attached base plates for structural members on adjusting nuts at anchor bolts. All anchor bolts shall have double nuts for adjusting.
 - 3. Tighten anchor bolts after the supported members have been positioned and plumbed. Do not remove adjusting nuts.
 - 4. Place non-shrink grout solidly between surfaces as shown to ensure that no voids remain. Finish exposed surfaces, protect installed materials and allow non-shrink grout to cure.
- F. Structural steel work shall be set accurately at established lines and levels. Steel shall be plumb and level before final bolting or welding is commenced and after complete erection. All cutting, notching, coping, etc., required for proper assembly and fitting of parts and members, shall be done by the steel fabricator. Such workmanship shall be equal in quality to shop work.
 - 1. Coordinate the erection of structural steel with other trades and locate temporary guys, braces, falsework and cribbing as may be necessary for erection so as not to interfere with the progress of other work.
 - 2. Rolled sections, except for minor details, shall not be heated except for welding operations.
 - 3. Upon acceptance by Architect, gas cutting may be permitted if the metal being cut is not highly stressed during the operation. Stresses shall not be transmitted through a flame cut surface unless such surfaces are cut by a mechanically guided torch. The radius of re-entrant flame cut fillets shall be as large as possible, but not less than 1 inch. To determine the net area of members so cut, 1/8 inch shall be deducted from the flame cut edges not made by a mechanically guided torch. Gas cuts shall be smooth and regular. Holes for bolts shall not be cut with a torch.
 - 4. All contact surfaces shall be cleaned before assembly.
 - 5. Provide setting diagrams and templates as required. Placement of beam connectors shall be the responsibility of structural steel fabricator.
 - 6. Splice members only where indicated.
- G. Connections shall be as specified hereinbefore under "Fabrication." In addition, bolted connections shall conform to the following requirements:
 - 1. Beveled washers shall be used under all bolt heads and nuts where they rest on beveled surfaces.
 - 2. Connectors shall have hexagon heads and nuts.
 - 3. Nuts shall be drawn up tight. Check threads of unfinished bolts with

chisel or approved self-locking nuts.

4. Bolts that have been completely tightened shall be marked with identifying symbol.
5. High-strength bolted construction: Install high-strength threaded fasteners in accordance with RCSC Specification for Structural Joints Using High-Strength Bolts. All high strength bolts shall be pretensioned, unless specifically noted otherwise. Pretensioning shall be by one of the methods permitted in RCSC Section 8.2.

- H. Framing shall be carried up true and plumb. Temporary bracing shall be introduced wherever necessary to take care of all loads to which structure may be subjected, including erection equipment and its operation. Such bracing shall be left in place as long as may be required for safety. It shall finally be removed by Contractor as part of his equipment. As erection progresses, the work shall be securely connected to take care of all dead load, lateral loads and erection stresses. No final bolting or welding shall be done until the structure has been properly aligned.

3.3 ERECTION TOLERANCES

- A. Level and plumb steel within the tolerances defined in the AISC Code of Standard Practice, latest edition.

3.4 REPAIRS AND PROTECTION

- A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint as specified or according to ASTM A780, and manufacturer's written instructions.
- B. Touchup Painting: After installation, promptly clean, prepare, and prime or re-prime field connections, rust spots, abraded surfaces of prime-painted joists and accessories, bearing plates, and abutting structural steel.
 1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
 2. Apply a compatible primer of same type as shop primer used on adjacent surfaces.

3.5 CLEAN-UP

- A. Upon completion of the work of this Section, remove all surplus materials, rubbish and debris from premises.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Steel decking and accessories:
 - 1. Standard decking profiles.
- B. Framing for openings up to and including 24 inches.

1.2 REFERENCES

- A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only. Refer to Division 01 for definitions, acronyms, and abbreviations.
- B. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- C. Referenced Standards:
 - 1. AISI S100 – North American Specification for the Design of Cold-Formed Steel Structural Steel Members.
 - 2. ASTM A108 – Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
 - 3. ASTM A653/A653M – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - 4. ASTM E329 – Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection.
 - 5. AWS D1.1 – Structural Welding Code – Steel.
 - 6. AWS D1.3 – Standard Welding Code – Sheet Steel.

1.3 SUBMITTALS

- A. Shop Drawings: Indicate decking plan, dimensions, sizes, support locations, projections, openings and reinforcement, pertinent anchoring details and accessories. Coordinate with other trades in accurately locating and detailing openings and penetrations.
- B. Product Data: Provide deck profile characteristics and dimensions, structural properties, finishes and accessories. Provide product data for acoustic insulation.
- C. Manufacturer's Installation Instructions: Indicate specific installation sequence and special instructions.
- D. Certificates:
 - 1. The manufacturer's certification and fire test reports to document that deck assemblies comply with requirements of this Section.
 - 2. Furnish certification by approved testing agency for each welder employed.

1.4 PERFORMANCE REQUIREMENTS

- A. Steel decking and section properties shall comply with AISI S100.
- B. Profile and design of deck units and accessories shall conform to the details shown on Drawings. Units shall be one piece, unless indicated otherwise.
- C. Steel decking and its installation shall meet the requirements of 2016 California Building Code (CBC).

1.5 FIELD MEASUREMENTS

- A. Verify that field measurements are as shown on shop drawings.

1.6 TESTS AND INSPECTIONS

- A. Furnish test specimens of materials when they are requested. Welded decking in place is subject to inspection and testing per CBC Chapter 17 "Special Inspections and Tests", Section 1705 "Required Special Inspections and Tests".
 - 1. Expense of removing and replacing any portion of decking for testing purposes will be borne by Owner if installation is found to be satisfactory. All portions of the work found to be defective and not in conformity with contract requirements shall be removed and replaced at no cost to Owner.

1.7 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency qualified according to ASTM E329 for testing indicated.
- B. Welding: Qualify procedures and personnel according to AWS D1.3.
- C. Installer: Company specializing in performing work of this Section.

1.8 DELIVERY, STORAGE AND HANDLING

- A. Deliver products to site under provisions of Division 01.
- B. Store and protect products under provisions of Division 01.
- C. Store decking on dry wood sleepers; slope for positive drainage. Work showing creases, burrs in cells, deformation, weathering, or other defects affecting its use will not be accepted.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturer, Standard Decking Profiles:
 - 1. Basis-of-Design: ASC Steel Deck, West Sacramento, CA; 916-372-6851, www.ascsd.com; per evaluation agency reports as follows:
 - a. IAPMO Evaluation Report No. ER-0161 for bare steel deck.
 - b. IAPMO Evaluation Report No. ER-0329 for concrete-filled steel deck.
- B. Substitutions: Under provisions of Division 01 with valid Evaluation Agency Report.

1. Substitution requests for steel decking shall consider the vertical and lateral load capacities of final system, including attachments. Provide a comparison summary of proposed and specified deck systems showing that the proposed system has equal or greater vertical and lateral load capacities for all conditions shown on Drawings. Systems with lower load capacities will not be acceptable.
2. Substitution requests will require review by the Structural Engineer of Record and Authority Having Jurisdiction (AHJ). Cost for such reviews shall be borne by Contractor.
3. Do not submit shop drawings with substituted decking manufacturer until decking manufacturer has been accepted via substitution request process.

2.2 MATERIALS

- A. Sheet Steel for Bare Deck: ASTM A653/A653M, SS designation, Grade 40 (minimum yield 38 KSI); zinc coated conforming to ASTM A653/A653M. Refer to Drawings for types, sizes, and thicknesses of zinc coating of steel decking.
- B. Sheet Steel for Composite Deck: ASTM A653/A653M, SS designation, Grade 40 for 3 inch Type "W" and "WF" deck profiles (minimum yield 40 KSI); zinc coated conforming to ASTM A653/A653M, G60, unless noted otherwise. Refer to Drawings for types and sizes of steel decking.
- C. Welding Materials: Conform to AWS D1.1 and D1.3, with a minimum 60 KSI filler metal yield strength.
- D. Shop and Touch-Up Zinc Rich Primer for Galvanized Surfaces: ZRC Galvilite Galvanizing Repair Compound as manufactured by ZRC Worldwide Company, Marshfield, MA; 800-831-3275, www.zrcworldwide.com, or accepted equal.
- E. Steel Decking and Design: Steel decking shall be metallic coated with interlocking side lap. Deck types and minimum structural properties shall be as indicated on Drawings. Submit Evaluation Agency Reports that demonstrate compliance with design requirements.
 1. Decking shall be vented with factory punched holes where filled with concrete; otherwise provide non-vented decking. Venting is not required at concrete filled deck where underside is permanently exposed or where cellular deck is used.
- F. Welded Headed Studs: ASTM A108. Welding testing and inspection shall be in accordance with AWS D1.1 and CBC Sections 1705.2.2, 1705.12 and 1705.13.
- G. Insulation at Acoustical Decking: Unfaced fiberglass batts provided and installed by decking manufacturer, cut to size for profile of decking.

2.3 FABRICATION

- A. Fabrication: All steel decking units shall be roll-formed to assure uniformity and strength.
- B. Allowable Tolerances: Maximum variation in unit alignment 1/4 inch in 40 feet (1/1920).

- C. Workmanship: All work shall be neat, trim, true to line and upon completion shall present a true finished surface of specified deck profile, free of dents, deformations, creases, weld spatter or other noticeable defects.
- D. Reinforcement: Provide reinforcement for openings, cutouts and free edges of decking as required for strength and stiffness. Provide reinforcement where a cell is cut parallel to rib as necessary to make a tight fit along the cut cell. Such reinforcement shall be in addition to structural supports shown on Drawings and specified in Section 05 12 00.
- E. Miscellaneous Work: Provide all other transition pieces, reinforcement and miscellaneous decking items as detailed and required to provide a complete installation.
- F. Where steel decking is scheduled to receive fireproofing or a paint finish, it shall be provided free of lubricants, oils, passivators, and other substances which would impair the adhesion of the fireproofing or paint system.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that field conditions are acceptable and are ready to receive work. Check supporting members for correct layout and alignment. Should layout and alignment be such as to prevent proper bearing of the deck units on supporting members, the deck installer shall bring it to the attention of structural steel installer in writing, with a copy to Architect, for corrective measures and action. Steel decking units shall not be placed until necessary corrections are made.
- B. Beginning of installation means installer accepts existing conditions.

3.2 INSTALLATION

- A. Erect steel decking in accordance with Evaluation Agency Report, manufacturer's instructions and final shop drawings.
- B. Placing and Fastening Deck Units: Place decking in a permanent position with all panels aligned end-to-end so that the fluted portions of the panels align accurately. Panels shall be placed on supporting framework and adjusted in final position before being permanently fastened. Ends shall be over structural supports with positive, complete bearing over full width of panels. Installation shall be accomplished without deformation of units. Decking layout shall be as indicated on Drawings.
 - 1. Carefully check control points, as indicated, for layout of deck flutes. Where required, deck module shall be adjusted to conform to layout indicated.
 - 2. Fasten deck units to structure and to each other as indicated.
 - 3. At galvanized steel decks, deslag, clean, and touch-up all welds with zinc-rich primer, including those at the underside of deck.
 - a. Exception: Do not touch-up welds on top of deck which will be covered with concrete.
 - 4. Complete installation shall conform to manufacturer's specifications and as detailed.

- C. Openings Through Decking: Steel decking fabricator shall cut and reinforce all openings in the metal deck, including framed openings indicated on Drawings. Small miscellaneous openings shall be field-cut by the trade requiring the opening.
 - 1. All cutting of exposed edges shall be square, trim and equal to factory cutting.
 - 2. Steel deck panels and accessories shall be cut and neatly fit around openings and other work projecting through the deck.
 - 3. Openings shall be reinforced as indicated or required to provide a rigid installation.
- D. Steel decking installation shall proceed in accordance with current Cal/OSHA and OSHA regulations including guidelines with respect to fall protection.
- E. Steel decking shall be spread for safety and working platforms.
- F. All steel decking sheets shall be wind tacked and loose bundles of deck shall be wired at the end of each shift.
- G. Concrete Filled Deck Installation:
 - 1. Provide deck accessories required to contain concrete during concrete placement.
 - 2. Concrete fill thicknesses over steel deck indicated on the construction documents are minimum thicknesses. Provide additional concrete fill as required to compensate for framing or deck deflections during placement in order to maintain specified surface tolerances and minimum thicknesses.
 - 3. Place concrete in a manner to avoid excessive deflections or ponding.
 - 4. Place concrete fill on adjacent spans before placement on cantilever conditions.
 - 5. Provide shoring where indicated on Drawings and where deck span exceeds manufacturer's listed maximum unshored span. Do not remove forms until concrete fill has reached its minimum compressive strength.

3.3 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Field welds will be subject to inspection.
- C. Remove and replace work that does not comply with specified requirements.
 - 1. Additional inspection, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.

3.4 PROTECTION

- A. Do not use steel decking for storage or working platforms until it has been permanently fastened. Storage loads must be supported on wood blocking in the flutes of the deck.
 - 1. Any damaged deck unit shall be repaired or replaced as directed by Architect and at no cost to Owner.

- B. Assure that construction loads do not exceed the carrying capacity of the deck.

3.5 CLEAN-UP

- A. Upon completion of the work of this Section, remove all surplus materials, rubbish and debris from premises.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Steel stud exterior wall framing.
- B. Exterior soffit joist framing.

1.2 REFERENCES

- A. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- B. Referenced Standards:
 - 1. AISI S100 – North American Specification for the Design of Cold-Formed Steel Structural Steel Members.
 - 2. AISI S200 – North American Standard for Cold-Formed Steel Framing – General Provisions.
 - 3. AISI S213 – North American Standard for Cold-Formed Steel Framing – Lateral Design.
 - 4. ASTM A653/A653M – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanized) by the Hot-Dip Process.
 - 5. ASTM A780 – Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
 - 6. ASTM A1003/ A1003M – Standard Specification for Steel Sheet, Carbon, Metallic and Nonmetallic-Coated for Cold-Formed Framing Members.
 - 7. ASTM C645 – Standard Specification for Nonstructural Steel Framing Members.
 - 8. ASTM C754 – Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products.
 - 9. ASTM C1007 – Standard Specification for Installation of Load Bearing (Transverse and Axial) Steel Studs and Related Accessories.
 - 10. ASTM C1513 – Standard Specification for Steel Tapping Screws for Cold-Formed Steel Framing Connections.
 - 11. AWS D1.1 – Structural Welding Code – Steel.
 - 12. AWS D1.3 – Structural Welding Code – Sheet Steel.
 - 13. SFIA – Steel Framing Industry Association.
 - 14. SSMA – Steel Stud Manufacturers Association.
 - 15. SSPC – Steel Structures Painting Manual.

1.3 SUBMITTALS

- A. Product Data: Provide data on standard framing members; describe materials and finish, product criteria and limitations.

- B. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.
- C. Evaluation Reports: For products not covered in SSMA or SFIA standards, submit current evaluation reports reviewed per the applicable building code.

1.4 QUALITY ASSURANCE

- A. Framing members shall be provided by a member of the Steel Stud Manufacturer's Association (SSMA) or Steel Framing Industry Association (SFIA).
- B. Calculate structural properties of framing members in accordance with American Iron and Steel Institute Cold-Formed Steel Design Manual AISI S100.

1.5 REGULATORY REQUIREMENTS

- A. Conform to 2016 California Building Code (CBC), Chapter 16 "Structural Design", Chapter 17 "Special Inspections and Tests", and Chapter 22 "Steel", as applicable.
- B. Materials:
 - 1. Structural Steel per CBC Chapter 22, Section 2202 "Definitions", and Section 2203 "Identification and Protection of Steel for Structural Purposes".
 - 2. Material Identification per CBC Chapter 22, Section 2203.1 "Identification".
- C. Inspection: CBC Chapter 17.
 - 1. Welding Inspection per Chapter 17, Section 1705, Paragraph 1705.2 "Steel Construction".

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the products specified in this Section.
- B. Installer: Company specializing in performing the work of this Section.

1.7 FIELD MEASUREMENTS

- A. Verify that field measurements are as indicated on shop drawings.

1.8 COORDINATION

- A. Coordinate with the placement of components within the stud framing system, specified in Divisions 21-23 and 25-28.

PART 2 - PRODUCTS

2.1 METAL FRAMING SYSTEM

- A. Acceptable Manufacturers:
 - 1. ClarkDietrich Building Systems
 - 2. Marino\WARE
 - 3. CEMCO

4. SCAFCO Steel Stud Company

B. Or accepted equal.

2.2 FRAMING MATERIALS

A. Steel Sheet: ASTM A1003/A1003M, Structural Grade, Type H, metallic coated, grade as follows:

1. Grade: ST33H for 18 gauge and lighter, ST50H for 16 gauge and heavier as required by structural performance requirements.

B. Sheet Steel for Vertical Deflection and Drift Clips: ASTM A1003/A1003M and ASTM A653/A653M, structural steel, zinc coated, of grade and coating as follows:

1. Grade: 50 (340).

2. Coating: G90 (Z275).

C. Studs, Zees, Angles and Plates: ASTM A1003/A1003M Steel sheet formed to channel shape, solid web; sizes and gauges, as indicated on Drawings.

D. Deflection Track Slotted: Single, deep-leg, U-shaped steel track: punched with vertical slots in both legs. Steel Sheet top runner manufactured to prevent cracking of finishes applied to framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.

E. Vertical Deflection Clips: Manufacturer's standard bypass and head clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web and capable of resisting forces imposed by the wall system.

F. Joists: ASTM A1003/ A1003M Grade 50, Class 1 or 2 sheet steel, formed to channel shape, punched web.

G. Headers and Jambs: Shapes used to form header beams and jambs, columns or posts, of web depths indicated, unpunched, with stiffened flanges.

H. Channel Bridging or Bracing: U-Channel Assembly: ASTM C645; Base metal thickness of 0.0538 inch, and minimum 1/2 inch wide flanges.

2.3 ACCESSORIES

A. Bracing, Furring, Bridging: Formed sheet steel, thickness determined for conditions encountered.

B. Plates, Gussets, Clips: Formed sheet steel, thickness as shown on Drawings.

C. Shop and Touch-Up Primer: TNEMEC Series 115 Uni-Bond DF or accepted equal, unless otherwise required to match shop primer.

D. Shop and Touch-Up Zinc Rich Primer for Galvanized Surfaces: ZRC Galvillite Galvanizing Repair Compound as manufactured by ZRC Worldwide Company, Marshfield, MA; 800-831-3275, www.zrcworldwide.com, or accepted equal.

2.4 FASTENERS

- A. Self-drilling, Self-tapping Screws, Bolts, Nuts and Washers: ASTM C1513, corrosion resistant.
- B. Welding: In conformance with AWS D1.1 and AWS D1.3.
- C. Power Actuated Fasteners: Refer to Drawings. All fasteners shall have Evaluation Agency approval.

2.5 FINISHES

- A. Framing Members and Connections:
 - 1. Provide galvanized finish per ASTM A653 as follows:
 - a. Typical Locations: G-60.
 - b. Elements Permanently Exposed to Un-conditioned Air: G-90.
 - 2. No equivalent coatings allowed.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify site conditions under provisions of Division 01.
- B. Verify that building framing components are ready to receive work.

3.2 ERECTION OF FRAMING

- A. Install components in accordance with ASTM C754, ASTM C1007, AISI S200, manufacturer's instructions, and as shown on Drawings.
- B. Align floor and top tracks; locate to wall layout. Secure in place by method shown on Drawings. Coordinate installation of sealant with floor tracks and studs attached to masonry or concrete walls.
- C. Place studs as shown on Drawings. Connect studs to tracks using method shown on Drawings.
- D. Construct corners using minimum three studs. Install double studs at wall openings and door and window jambs unless otherwise shown on Drawings.
- E. Erect studs one piece full length. Splicing of studs is not permitted.
- F. Erect studs; brace and reinforce to develop full strength to achieve design requirements.
- G. Install intermediate studs above and below openings to align with wall stud spacing.
- H. Provide deflection allowance in stud track, directly below horizontal building framing at non-load bearing framing.
- I. Attach furring channels to studs for attachment of fixtures anchored to walls.
- J. Install framing between studs for attachment of mechanical and electrical items and to prevent stud rotation.

- K. Touch-up field welds and damaged galvanized surfaces with primer.
- L. Complete framing ready to receive exterior finish system.
 - 1. Backing/Blocking: Shall be provided for all interior finishes and exterior finish systems, and for the supporting and anchorage of products, fixtures and equipment for all trades. Coordinate size, type, and location of backing and supports with manufacturer or supplier of items requiring backing/blocking.

3.3 ERECTION OF JOISTS

- A. Install framing components in accordance with manufacturer's instructions.
- B. Make provisions for erection stresses. Provide temporary alignment and bracing.
- C. Place joists as shown on Drawings. Connect joists to supports as indicated on Drawings.
- D. Set joists parallel and level, with lateral bracing and bridging.
- E. Provide joist bridging at mid-point of spans or not to exceed 8 feet on center.
- F. Touch-up field welds and damaged galvanized surfaces with primer.
- G. Complete framing ready to receive finish.

3.4 REPAIRS AND PROTECTION

- A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint as specified or according to ASTM A780, and manufacturer's written instructions.
- B. Touchup Painting: After installation, promptly clean, prepare, and prime or re-prime field connections, rust spots, and abraded surfaces of prime-painted joists and accessories and abutting steel.
 - 1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
 - 2. Apply a compatible primer of same type as shop primer used on adjacent surfaces.

3.5 ERECTION TOLERANCES

- A. Maximum Variation from True Position: 1/8 inch.
- B. Maximum Variation of any Member from Plane: 1/8 inch.

END OF SECTION

PART 1 GENERAL

1.1 SUMMARY

- A. This Section Includes:
1. The requirements for furnishing and installing metal fabrications made from steel shapes, plates, bars, strips, tubes, pipes and castings not a part of structural steel or specified in other Sections.
- B. References:
1. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only. Refer to Division 01 for definitions, acronyms, and abbreviations.
 2. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
 3. American Iron and Steel Institute (AISI):
 - a. AISI S100-16w/S1-18: North American Specification for the Design of Cold-Formed Steel Structural Steel Members.
 - b. AISI S200-12: North American Standard for Cold-Formed Steel Framing – General Provisions.
 - c. AISI S213-07/S1-09-2012: North American Standard for Cold-Formed Steel Framing – Lateral Design.
 4. American Society of Testing Materials (ASTM):
 - a. ASTM A27/A27M-19: Standard Specification for Steel Castings, Carbon, for General Application.
 - b. ASTM A36/A36M-19: Standard Specification for Carbon Structural Steel.
 - c. ASTM A47/A47M-99(2018)e1: Standard Specification for Ferritic Malleable Iron Castings.
 - d. ASTM A48/A48M-03(2016): Standard Specification for Gray Iron Castings.
 - e. ASTM A53/A53M-18: Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - f. ASTM A123/A123M-17: Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - g. ASTM A153/A153M-16a: Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - h. ASTM A500 / A500M – 18: Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
 - i. ASTM A501/A501M-14: Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
 - j. A653/A653M-19a: Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanized) by the Hot-Dip Process.
 - k. ASTM A992/A992M-11(2015) Standard Specification for Structural Steel Shapes.
 - l. ASTM A1008 / A1008M – 18: Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
 - m. ASTM A1011/A1011M-18a: Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
 5. American Welding Society (AWS):
 - a. AWS D1.1: Structural Welding Code – Steel.
 - b. AWS D1.2: Structural Welding Code – Aluminum.
 - c. AWS D1.3: Structural Welding Code – Sheet Steel.
 - d. AWS D1.8: Structural Welding Code – Seismic Supplement.

6. Society for Protective Coatings (SSPC).
 - a. Paint 20: Zinc-Rich Coating Type I Inorganic and Type II Organic.

1.2 PERFORMANCE REQUIREMENTS:

- A. Railings: Design, engineer, fabricate and install railings to withstand the following structural loads:
 1. Top Rail of Railing System: Capable of withstanding a concentrated load of 300-pounds applied at any point and a uniform load of 50-pounds per linear foot applied at any direction.
 2. Railings shall comply with California Building Code requirements.

1.3 SUBMITTALS

- A. All submittals shall be made under the provisions of Section 01 33 00 Submittal Procedures. Contractor initial submittal shall include 'Submittal Items' requested below. 'Closeout Submittal Items' shall be provided as required by Section 01 77 00 Closeout Procedures.
- B. Submittal No. 05 50 00A – Product Data:
 1. Manufacturer's specifications, anchor details and installation instructions, including paint products and grout.
- C. Submittal No. 05 50 00B - Shop Drawings:
 1. Include plans, elevations and details of metal fabrications and their connections. Show anchorage and accessory items.

1.4 QUALITY ASSURANCE

- A. Fabricator Qualifications: Firm experienced in successfully producing metal fabrications similar to that indicated for this Project, with sufficient production capacity to produce required units without causing delay in the work.
- B. Welding Qualifications: Qualify welding processes and welding operators in accordance with AWS D1.1, D1.2, D1.3, and D1.8 as applicable. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved.

1.5 PROJECT CONDITIONS

- A. Field Measurements: Check actual locations of walls and other construction to which metal fabrications must fit, by accurate field measurements before fabrication. Show recorded measurements on shop drawings. Coordinate fabrication schedule to avoid delay of work.

1.6 SEQUENCING AND SCHEDULING

- A. Painting: Items specified in this Section as having a shop applied prime coat will be job painted as specified in Section 09 91 00, unless otherwise noted.
- B. Furnish templates for anchors and bolt installation by other Sections.

PART 2 PRODUCTS

2.1 MATERIALS

- A. General: For fabrication of metal work, which will be exposed to view, use only materials which are smooth and free of surface blemishes including pitting, seam marks, roller marks,

rolled trade names and roughness.

- B. Wide Flange Steel Shapes: ASTM A992
- C. Steel Plates, Shapes and Bars: ASTM A36
- D. Steel Tubing: Cold formed, ASTM A500; or hot rolled, ASTM A501
- E. Structural Steel Sheet: Hot rolled, ASTM A1011; or cold rolled ASTM A1008
- F. Galvanized Structural Steel Sheet: ASTM A653
- G. Steel Pipe: ASTM A53; type and grade selected by fabricator; black finish unless galvanizing is indicated or specified; standard weight, schedule 40, unless otherwise indicated.
- H. Gray Iron Castings: ASTM A48, Class 30
- I. Malleable Iron Castings: ASTM A47, grade selected by fabricator
- J. Brackets, Flanges and Anchors: Cast or formed metal of same type material and finish as supported rails, unless otherwise indicated
- K. Concrete Inserts: Threaded or wedge type; galvanized ferrous castings, either malleable iron, ASTM A47, or cast steel, ASTM A27. Provide bolts, washers and shims as required, hot dip galvanized, ASTM A153.
- L. Fasteners: Steel fasteners, galvanized in accordance with ASTM A153, selected by fabricator
- M. Paint:
 - 1. Metal Primer: SSPC 20, Type 2
 - a. Exterior Exposure: Tnemec 90-97 Tnemec Zinc or Architect approved substitute.
 - b. Interior Exposure: Tnemec 18 Enviro-Prime acrylic emulsion rust-inhibitive primer or Architect approved substitute.
 - c. Exposed to view items to be field painted shall be primed with a primer compatible with final finish coats specified in Section 09 91 00.
 - 2. Galvanizing Repair Paint: High zinc dust content paint for re-galvanizing welds in galvanized steel; Rust Oleum Corp. "Zinc Rich Cold Galvanizing Compound", Tnemec 90 93, ZRC Chemical Products Div. of Norfolk Corp. "ZRC Cold Galvanizing Compound" or Architect approved substitute.

2.2 MANUFACTURED ITEMS

- A. Ships Ladder: O'Keeffe's 523 ships ladder. 75" angle aluminum construction or Architect approved substitute.
 - 1. O'Keeffe's, 100 N Hill Dr., #12, Brisbane, CA 94005, (888) 653-3333, info@okeeffes.com, <https://okeeffes.com/>

2.3 FABRICATION, GENERAL

- A. Workmanship:
 - 1. Use materials of size and thickness indicated or required to produce strength and durability in finished product for use intended.
 - 2. Work to dimensions indicated,
 - 3. Form exposed work true to line and level with accurate angles and surfaces and straight,

- sharp edges.
4. Ease exposed edges to a radius of approximately 1/32 inch, unless otherwise indicated.
 5. Form bent metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
 6. Weld corners and seams continuously, complying with AWS recommendations. At exposed connections, grind exposed welds smooth and flush to match and blend with adjoining surfaces. Welds shall be imperceptible in the finished work.
 7. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners wherever possible. Use Phillips flat head countersunk screws or bolts for exposed fasteners, unless tamperproof security screws are indicated.
 8. Cut, reinforce, drill and tap miscellaneous metal work as indicated to receive finish hardware and similar items.
- B. Galvanizing: Provide zinc coating for items indicated or specified to be galvanized, as follows:
1. ASTM A153 for galvanizing iron and steel hardware.
 2. ASTM A123 for galvanizing both fabricated and un-fabricated iron and steel products made of uncoated rolled, pressed, and forged shapes, plates, bars, and strip 0.0299-inch thick and heavier.
- C. Fabricate joints exposed to the weather to exclude water or provide weep holes.
- D. Shop Painting:
1. Shop paint miscellaneous metal work, except members or portions of members to be embedded in concrete or masonry, surfaces and edges to be field welded, and galvanized surfaces.
 2. Remove scale, rust and other deleterious materials before applying shop coat. Clean off heavy rust and loose mill scale in accordance with SSPC SP 2, SP 3, or SP 7.
 3. Remove oil, grease and similar contaminants in accordance with SP 1.
 4. Brush or spray on primer in accordance with manufacturer's instructions, at a rate of 2.0 mils thickness for each coat.
 5. Apply one shop coat to fabricated metal items, except apply 2 coats to inaccessible surfaces after assembly or erection. Change color of second coat to distinguish from the first.
 6. Primer on exposed to view items to be field painted shall be smooth and suitable for application of final finish coats specified in Section 09 91 00.
 7. Apply a heavy coat of bituminous paint, compounded for application in 30 mil coat, to metal surfaces in contact with concrete, masonry and dissimilar metals. Do not apply on exposed surfaces.

2.4 MISCELLANEOUS METAL FABRICATIONS

- A. Ships Ladder:
1. Fabricate for locations indicated, with dimensions, spacing, and anchorages as provided.
 2. Use aluminum shapes for stringers.
 3. Use aluminum extruded treads with serrations, 4-inches wide.
 4. Design components and fastenings to support its own weight plus 100-psf distributed load and 300-pound concentrated load.
 5. Railings: Fabricate to details indicated. Railing shall withstand a minimum concentrated load of 200-pounds applied in any direction at any point on the top rail and a horizontal thrust of 50-pounds per linear foot.
 6. Finish: Clear anodized finish.
- B. Loose Bearing and Leveling Plates: Provide for steel items bearing on masonry or concrete construction, made flat, free from warps or twists, and of required thickness and bearing

- area. Drill to receive anchor bolts and for grouting as required. Galvanize after fabrication.
- C. Curb Nosings:
 - 1. Fabricate of structural steel shapes of welded construction with mitered corners and continuously welded joints.
 - 2. Provide anchors welded to nosings for embedding in concrete or masonry construction, spaced not more than 6-inches from each curb end, 6-inches from corners and 24-inches on center unless otherwise indicated.
 - 3. Finish: Galvanized
 - D. Miscellaneous Framing and Supports:
 - 1. Provide miscellaneous framing and supports not a part of structural steel framework, as required to complete work.
 - 2. Fabricate to sizes, shapes and profiles shown or required.
 - 3. Fabricate from structural steel shapes and plates and steel bars of welded construction using mitered joints for field connection.
 - 4. Cut, drill and tap units to receive hardware and similar items.
 - 5. Furnish integrally welded anchors for casting into concrete or building into masonry.
 - 6. Finish: Galvanize exterior frames and supports, shop prime interior frames and supports.
 - E. Steel Pipe or Tube Railings: Fabricate to design, dimensions and details indicated.
 - 1. Interconnect railing members by butt welding or welding with internal connectors.
 - 2. Provide coped joints at tee and cross sections.
 - 3. Form simple and compound curves by bending pipe or tubing in jigs to produce uniform curvature for each repetitive configuration. Maintain cylindrical cross section of pipe or tube throughout entire bend without buckling, twisting or deforming exposed surfaces.
 - 4. Close exposed ends of pipe by welding 3/16 inch steel plate in place or by using prefabricated fittings.
 - 5. Flanges, Fittings and Anchors: Provide end closures, flanges, miscellaneous fittings and anchors for interconnections of pipe or tubing and attachment of railings to other work. Furnish inserts and other anchorage devices for connecting to concrete or masonry.
 - 6. Finish: Galvanize steel railings, including pipe or tubing, fittings, brackets, fasteners, and other ferrous components.
 - F. Bollards: Fabricate bollards from galvanized steel pipe of diameter and height indicated. Embed in concrete footings, fill with concrete and close top end by welding a 1/4 inch steel plate in place or provide a smooth concrete domed cap.

PART 3 EXECUTION

3.1 PREPARATION

- A. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions, and directions for installation of anchorages, such as concrete inserts, sleeves, anchor bolts and miscellaneous items having integral anchors.

3.2 INSTALLATION

- A. General:
 - 1. Fastening to In Place Construction: Provide threaded fasteners for concrete and masonry inserts, toggle bolts, through bolts, lag bolts, wood screws and other connectors as required
 - 2. Cutting, Fitting and Placement:
 - a. Perform cutting, drilling and fitting required for installation of miscellaneous metal fabrications.

- b. Set work accurately in location, alignment and elevation, plumb, level, true and free of rack, measured from established lines and levels.
 - c. Provide temporary bracing or anchors in formwork for items to be built into concrete, masonry or similar construction.
 3. Fit exposed connections together forming tight hairline joints.
 - a. Weld connections not shop welded.
 - b. Grind exposed joints smooth and imperceptible, and touch up shop paint coat.
 - c. Do not weld, cut or abrade the surfaces of exterior units which have been hot dip galvanized after fabrication, and intended for bolted or screwed field connections.
 4. Field Welding: Comply with AWS for procedures of manual shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work.
 5. Install prefabricated items in accordance with manufacturer's instructions.
- B. Setting Loose Plates:
 1. Clean concrete and masonry bearing surfaces of bond reducing materials, and roughen to improve surface bond. Clean bottom surface of bearing plates.
 2. Set loose leveling and bearing plates on wedges, or other adjustable devices.
 3. Tighten anchor bolts after the bearing members have been positioned and plumbed.
 4. Cut off protruding ends of wedges flush with the edge of the bearing plate before packing with grout.
 5. Use metallic non shrink grout in concealed locations where not exposed to moisture; use nonmetallic non shrink grout in exposed locations.
 6. Pack grout solidly between bearing surfaces and plates to ensure no voids remain.
- C. Steel Pipe or Tube Railings:
 1. Adjust railings prior to anchoring to ensure matching alignment at abutting joints.
 2. Space posts as indicated.
 3. Plumb posts in each direction.
 4. Anchor posts in concrete by core-drilling concrete curbs to accommodate the posts. Fill annular space between post and curb solid with non-shrink, non-metallic grout mixed and placed to comply with grout manufacturer's directions.
 5. Anchor posts to steel with steel oval flanges, angle type or floor type as required by conditions, welded to posts and bolted to steel supporting members.
 6. Expansion Joints: Provide at intervals not exceeding 40 feet. Provide slip joint with internal sleeve extending 2 inches beyond joint on either side; fasten internal sleeve securely to one side; locate joint within 6 inches of posts.
- D. Bollards: Anchor bollards in concrete with preset pipe sleeves. After bollards have been inserted into sleeves, fill annular space between bollard and sleeve solid with non-shrink, nonmetallic grout.

3.3 ADJUST AND CLEAN

- A. Touch-Up Painting: Clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material used for shop painting. Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Galvanized Surfaces: Clean field welds, bolted connections and abraded areas and spot prime with specified primer applied to a minimum dry film thickness of 2.5 mils.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Steel stair frame of structural sections.
- B. Treads, landings, and closed risers.
- C. Railing assemblies.

1.2 REFERENCES

- A. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- B. Referenced Standards:
 - 1. ASTM A36/A36M – Standard Specification for Carbon Structural Steel.
 - 2. ASTM A53/A53M – Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - 3. ASTM A123/A123M – Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - 4. ASTM A500 – Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
 - 5. ASTM A1011/A1011M – Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
 - 6. AWS A2.0 – Standard Welding Symbols.
 - 7. AWS D1.1 – Structural Welding Code – Steel.
 - 8. SSPC-Paint 20 – Zinc-Rich Coating, Type I-Inorganic and Type II-Organic.

1.3 SUBMITTALS

- A. Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, accessories and interfaces with adjacent building elements.
 - 1. Include erection drawings, elevations and details where applicable.
 - 2. Indicate welded connections using standard AWS A2.0 welding symbols. Indicate net weld length.
 - 3. Stair fabricator shall not add any structural elements to the stair that would affect the design of adjacent building elements.
 - 4. All drawings and details shall be signed and stamped by a Structural Engineer with a current and valid license in the State of California.

- B. Templates: Furnish templates and other devices as necessary for presetting bolts and anchors to accurate conditions.
- C. Descriptive Data: Submit complete data for manufactured items.

1.4 QUALITY ASSURANCE

- A. Conform to CBC Chapters 17 and 22.
 - 1. Materials:
 - a. Structural Steel, Cold Formed Steel as per CBC Section 2205.
 - b. Material Identification as per CBC Section 2203.1.
 - 2. Inspection and Tests:
 - a. Test of High Strength Bolts, Nuts, Washers as per CBC Section 2212.6.1.
 - b. Welding Inspection as per CBC Section 1705.2.5.
 - c. Inspect bolted joints per RCSC Section 9 and CBC Section 1705.2.1.
 - d. Non-Destructive Weld Testing as per CBC Section 1705.12.1.

1.5 QUALIFICATIONS

- A. Fabricator/Installer: For the fabrication and installation of steel stairs, use only personnel who are trained and experienced in the products involved and in the recommended methods for their installation.
- B. Welders' Certificates: Submit under provisions of Division 01, certifying welders employed on the Work, verifying AWS qualification within the previous twelve months.

1.6 FIELD MEASUREMENTS

- A. Take field measurements prior to the preparation of shop drawings and fabrication where possible.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Coordinate all fabrication and delivery of steel stairs with all related trades to permit stair installation into the structure without delay.
- B. Deliver all parts ready for erection; store on clean concrete surface or raised platforms under cover.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Metal Surfaces: For fabrication of steel stair work which will be exposed to view, use only materials which are smooth and free of surface blemishes including pitting, seam marks, roller marks, rolled trade names and roughness. Remove blemishes by grinding and/or welding and grinding prior to cleaning, treating and application of surface finish.
 - 1. All interior steel components shall receive one coat of shop primer.
- B. Structural Steel Plates, Shapes and Bars: ASTM A36/A36M.

- C. Hot-Rolled Carbon Steel Sheets and Strips: ASTM A1011/A1011M.
- D. Sheet Steel: ASTM A1011/A1011M, Grade B Structural Quality.
- E. Steel Pipe: ASTM A53/A53M, Type S, Grade A and ASTM A500 Grade B.
- F. Hollow Structural Sections: ASTM A500 Grade B.
- G. Welding Materials: AWS D1.1, type required for materials being welded.
- H. Bolts, Nuts and Washers: Manufacturer's standard.
- I. Steel Shop and Touch-Up Primer: TNEMEC Series 115 Uni-Bond DF or accepted equal.
- J. Shop and Touch-Up Zinc Rich Primer for Galvanized Surfaces: ZRC Galvilite Galvanizing Repair Compound as manufactured by ZRC Worldwide Company, Phone: (800) 831-3275, or accepted equal.
- K. Handrail brackets at walls shall be steel, as indicated on Drawings.

2.2 FABRICATION

- A. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; unobtrusively located; consistent with design of component, except where specifically noted otherwise.
- B. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.
- C. Accurately form components required for anchorage of stairs and landings and railings to each other and to building structure.
- D. All stair fasteners shall be provided and installed by stair manufacturer.
- E. Form work true to line and level with accurate angles and surfaces and straight sharp edges. Ease exposed edges to radius of approximately 1/32 inch. Form bent metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- F. Weld corners and seams in accordance with recommendations of AWS. Grind these exposed welds to match and blend with adjoining surfaces.
- G. Join rails and corners by mitered and welded joints made by fitting top rail and intermediate rails in a unit and bracketed, or weld to posts as indicated. Butt railing splices and reinforce by a tight fitting interior sleeve. Plumb posts in each direction. Secure posts by welding direct to stair stringers.
- H. Remove scale, rust and other deleterious materials before applying shop primer. Apply one shop coat of metal primer to all fabricated metal items.
- I. Clean surfaces of rust, scale, grease and foreign matter prior to finishing.
- J. Do not prime surfaces in direct contact with concrete or where field welding is required.
- K. Prime paint items with one coat of metal primer.

- L. Clean and strip primed steel items to bare metal where site welding is required.
- M. Fit and shop-assemble in largest practical sections, for delivery to site.
- N. Fabricate components with joints tightly fitted and secured.
- O. Continuously seal jointed pieces by continuous welds.
- P. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush and hairline. Ease exposed edges to small uniform radius.

2.3 RAILING ASSEMBLIES

- A. Fabricate from 1-1/2 inch outside diameter, ASTM A53 schedule 40 galvanized steel pipe; provide matching wall railings.
- B. Pickets: 1/2 inch diameter galvanized steel.
- C. Wall Railings: Install with specified brackets spaced and anchored as indicated. Return handrails to wall. Provide welded steel end caps at returns.
- D. Fabrication:
 - 1. Handrail gripping surfaces and any surfaces adjacent to them shall be free of sharp or abrasive elements and shall have rounded edges.
 - 2. Handrails shall not rotate in their fittings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that field conditions are acceptable and are ready to receive work.
- B. Beginning of installation means erector accepts existing conditions.
- C. Verify alignment with adjacent construction. Coordinate related work.

3.2 PREPARATION

- A. Clean and strip primed steel items to bare metal where site welding is required.
- B. Supply items required to be cast into concrete and/or embedded in masonry with setting templates, to appropriate Sections.

3.3 INSTALLATION

- A. Erect stairs, landings and railings as shown on approved shop drawings, level and plumb, accurately fitted, free from distortion or defects detrimental to appearance or performance.
- B. Provide anchors, plates, angles, hangers and struts required for connecting stairs to structure.
- C. Allow for erection loads and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.
- D. Field-weld components indicated on shop drawings. Perform field welding in accordance with AWS D1.1.

- E. Field-bolt and weld to match shop bolting and welding. Conceal bolts and screws whenever possible. Where not concealed, use flush countersunk fastenings.
- F. Mechanically fasten joints butted tight, flush and hairline. Grind welds smooth and flush.
- G. Obtain Architect acceptance prior to site cutting or making adjustments not scheduled.
- H. After erection, prime welds, abrasions and surfaces not shop primed, except surfaces to be in contact with concrete and surfaces damaged during construction. Touch-up shall be with same paint as prime coat.
- I. Railings:
 - 1. Standing Railing: Position standing rail on stringers as indicated on Drawings and clamp in desired alignment. Finish weld railing posts and railing ends in place.
 - 2. Wall Railings: Install with specified brackets spaced and anchored as indicated on Drawings. Return handrails to wall.
- J. Concrete:
 - 1. After stair erection, and prior to concrete fill, install temporary wood infill at all tread and landing pans. Wood infill shall be flush with top of pans.
 - 2. Remove temporary wood infill and install concrete with welded wire fabric at stair treads and landings under provisions of Section 03 30 00.
 - 3. Install metal tread nosings as indicated on Drawings.

3.4 ERECTION TOLERANCES

- A. Maximum Variation from Plumb: 1/4 inch per story, non-cumulative.
- B. Maximum Offset from True Alignment: 1/4 inch.

END OF SECTION

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Prefabricated egress barrier gates for stairwells.

1.2 REFERENCES

- A. American Welding Society (AWS) D1.1/D1.1M - Structural Welding Code - Steel.
- B. ASTM International (ASTM):
 - 1. A36/A36M - Standard Specification for Carbon Structural Steel.
 - 2. E2072 - Standard Specification for Photoluminescent (Phosphorescent) Safety Markings.
- C. International Code Council (ICC):
 - 1. International Building Code (IBC).
 - 2. International Fire Code (IFC).
- D. National Fire Protection Association (NFPA) 101 - Life Safety Code.
- E. Underwriters Laboratories, Inc. (UL) 1994 - Standard for Luminous Egress Path Marking Systems.
- F. United States Department of Justice (USDOJ) - ADA Standards for Accessible Design (SAD).

1.3 SUBMITTALS

- A. Product Data: Manufacturer's descriptive data including dimensions, materials, finishes, and mounting details.
- B. Certificate of Compliance: Show product compliance with reference standards.
- C. Maintenance Data: Include recommendations for sign cleaning and routine maintenance.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Minimum 2 years' experience in work of this Section.
- B. Provide "No Exit" signs in accordance with NFPA 101.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Store signs in cool, dry location in original packaging until installed.
- B. Store gates above ground on platforms, skids, or other supports; separate with wooden separators.
- C. Protect steel from corrosion.
- D. Prevent damage to prime coat.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design: EgressGate
- B. Or Accepted Equal.

2.2 MATERIALS

- A. Steel Shapes, Tube, Pipe, and Plate: ASTM A36/A36M.
- B. Hinges: Self-closing type, single acting, of sufficient spring power to completely close gate without excessive noise upon impacting strike plate.
- C. Photoluminescent Sign Luminance Properties: ASTM E2072 and UL 1994.
 - 1. From test sample activation: 10.76 lx (1.000 fc) for 60.0 minutes:
 - a. For 10 minutes after lights go out: Minimum 30 mcd per square meter.
 - b. For 60 minutes after lights go out: Minimum 7 mcd per square meter.
 - c. For 90 minutes after light go out: Minimum 5 mcd per square meter.

2.3 MANUFACTURED UNITS

- A. Metal Egress Barrier Gates:
 - 1. Comply with requirements of IBC and NFPA 101.
 - 2. Provide barrier in stairwells to prevent accidental travel beyond designated exit level.
 - 3. 90 to 180 degree opening.
 - 4. Self-closing and self-stopping.
 - 5. Universal mounting.
 - 6. Width: Adjustable to fit openings up to 60 inches.
 - 7. Height: 32 inches.
- B. "No Exit" Signs:
 - 1. Description: Non-flexible photoluminescent sign with black markings.
 - 2. Listed to UL 1994.
 - 3. Size: 12 x 9 inches.
 - 4. Conform to CBC for sign design and content.

2.4 FABRICATION

- A. Shop assemble gates, ready for delivery to site.
- B. Fabricate with joints tightly fitted and secured.
- C. Welding to conform to AWS D1.1/D1.1M. Grind exposed welds smooth.
- D. Ease exposed edges to small uniform radius.
- E. Equip each gate with:
 - 1. Universal mounting.
 - 2. Two hinges.
 - 3. Steel stop plate welded to gate, with slotted bolt holes for adjustment.
 - 4. Steel sign plate with photoluminescent "No Exit" sign welded to gate.

2.5 FINISHES

- A. Ferrous Metal: Shop painted with one coat red oxide primer paint.
- B. Field paint to match handrails.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install gates in accordance with manufacturer's instructions.
- B. Weld anchor plates to mounting bars if required based on adjacent construction.
- C. Install backing to stud walls to accept gate mounting anchors.
- D. Weld stop plate to gates.
- E. Extend gates to required width, then weld expansion joints on top and bottom tubes.
- F. Welding to conform to AWS D1.1/D1.1M. Grind welds smooth.
- G. Hand paint gate to match final egress system finish.
- H. Apply photoluminescent "No Exit" Sign to sign plate.

3.2 ADJUSTING

- A. Clean and touch up damaged primer paint with same product as applied in shop.

END OF SECTION

PART 1 GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Finish Carpentry Items, Other Than Shop Fabricated Architectural Casework.

1.2 REFERENCES

- A. Unless otherwise noted, standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes as of the date of issue of this Project Manual.
- B. Referenced Standards:
 - 1. WI/AWI Architectural Woodwork Standards, including Supplemental Text.

1.3 SUBMITTALS

- A. Shop Drawings: Shop drawings shall include details and erection data associated with the work of other trades; location; materials, species of wood; quality grade; type of finish; profiles, dimensions; fastenings and clearances. Detail drawings shall be either full size or 3 inches equal 1 foot.

1.4 QUALITY ASSURANCE

- A. Standards of Construction: All work shall be manufactured in accordance with WI/AWI Architectural Woodwork Standards, all supplements, and in the grades hereinafter specified.
- B. Installer's Qualifications: Use only journeymen finish carpenters who are thoroughly trained and experienced in the skills required for the cutting and fitting of trim and finish materials.
- C. Installation Acceptance: All rejected work shall be removed and replaced with no additional cost to the County.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Delivery: Do not deliver to the job site until suitable storage space is available.
- B. Storage, Handling and Protection: Provide all work or materials necessary to store, cover and protect all materials specified to be furnished and installed under this Section. Store all materials under cover in a well-ventilated enclosure and protect against extreme changes in temperature and humidity. Avoid any marring and keep the materials clean during handling and installation operations. Protect exposed finish work and materials after their erection from damage of any character. Work damaged shall be repaired or replaced by the Contractor without additional cost to the County.

PART 2 PRODUCTS

2.1 MATERIALS

- A. All Material Grades and Construction shall be WI Custom Grade, including all supplements, unless specified or indicated otherwise. Semi-exposed and other components shall be as permitted by WI standards for construction quality specified herein except as otherwise detailed or specified. Moisture content shall be in accordance with WI/AWI Architectural

Woodwork Standards.

- B. Interior Plywood:
 - 1. Plywood backing for electrical, telephone and similar types of wall mounted equipment shall be provided hereunder where required. Plywood shall be 3/4" thick A-C Fire Rated EXT-APA Douglas Fir with "A" face exposed.

PART 3 EXECUTION

3.1 CONDITIONS OF SURFACES

- A. Examine all framing, grounds, stripping and blocking to secure finish carpentry and trim. Do not install finish carpentry and trim until all defects are corrected.

3.2 INSTALLATION

- A. Workmanship Quality: All wood materials and finishes shall be installed level, plumb and true, with members neatly and accurately scribed in place. All trim shall be applied in lengths as long as practicable. Butt joints shall be beveled together, exterior angles mitered and interior angles coped, unless shown otherwise. All exposed nails and screws shall be set for putty unless indicated or specified otherwise.

3.3 CLEAN-UP

- A. General: Keep the premises in a neat, safe and orderly condition at all times during execution of this portion of the work, free of accumulations of sawdust, cut-ends and debris.
- B. Clean-up: Upon completion of the work of this Section, remove all surplus materials, rubbish and debris from the premises and leave "broom clean".

END OF SECTION

PART 1 GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Custom fabricated casework.
 - 2. Countertops.
 - 3. Solid Surfacing.
 - 4. Cabinet hardware.

- B. References:
 - 1. The publications listed below form a subsection of this Section to the extent referenced. The publications are referred to in the text by the basic designation only.
 - 2. Unless otherwise noted, standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes as of the date of issue of this Project Manual.
 - 3. American National Standards Institute (ANSI):
 - a. ANSI 135.4: Basic Hardboard Standard.
 - b. ANSI A208.1: Particleboard Standard.
 - c. ANSI A208.2: Standard for Medium Density Fiberboard for Interior Applications.
 - d. ANSI/BHMA 156.9: Cabinet Hardware.
 - 4. American Society of Testing Materials (ASTM):
 - a. ASTM E84: Standard Test Method for Surface Burning Characteristics of Building Materials.
 - 5. National Electrical Manufacturers Association (NEMA):
 - a. NEMA LD3: High-Pressure Decorative Laminates.
 - 6. American Plywood Association (APA):
 - a. PS 1: Construction and Industrial Plywood.
 - b. PS 20: American Softwood Lumber Standard.
 - c. PS 51-71: Hardwood and Decorative Plywood.
 - 7. WI/AWI Architectural Woodwork Standards, including Supplemental Text.

1.2 SYSTEM DESCRIPTION

- A. Casework design and construction shall be in accordance with WI/AWI Architectural Woodwork Standards as follows:
 - 1. Grade: Premium.
 - 2. Construction Style: A – Frameless.
 - 3. Construction Type: Type I – Multiple Self Supporting Units.
 - 4. Door and drawer front style: Flush overlay.
 - 5. Shelves: Conform to WI requirements subject to a 50 psf uniformly spaced load not to exceed 200 pounds per shelf.
 - 6. Provide seismic anchorage in accordance with CBC.

1.3 SUBMITTALS

- A. General: Begin fabrication only after required approvals have been obtained.

- B. Shop Drawings:
 - 1. Shop Drawings: Comply with Section 1 of WI/AWI Architectural Woodwork Standards – Basic Requirements for Architectural Millwork Shop Drawings. Submit as follows:
 - a. Submit 2 copies of shop drawings (11 inch by 17 inch minimum size).
 - b. Architect furnished drawings indicate form and profile concept only. Submit shop drawings to illustrate Fabricator's understanding of Architect's drawings and to

show intended fabrication details. A photocopy or traced copy of architectural drawings is not acceptable.

- c. Prepare shop drawings using field verified dimensions. Report any major discrepancies between Architect's drawings and field dimensions before work fabrication.
 - d. Indicate casework conditions, identified with location, grade, type of finish, and wood species.
 - e. Show casework in relation to adjacent construction with sectional drawings at full size or at 3 inch to 1 foot scale.
 - f. Coordinate dimensions of built-in equipment and fixtures. Show casework hardware indicating brand name and model used.
 - g. Show special accessory components not included in manufacturer's product data.
 - h. Show anchoring and attachment method. Show seismic restraint in accordance with CBC. Show method of scribing.
- C. Samples: Submit finish samples as follows:
1. Two 6 inch by 12 inch samples of each.
 2. Two 6 inch by 12 inch samples of each type of countertop finish.
 3. One sample of each type of cabinet hardware.

1.4 QUALITY ASSURANCE

- A. Qualifications:
 1. Manufacturer Qualifications: Firm specializing in manufacturing products specified in this Section with a minimum 5 years' experience.
 2. Installer Qualifications: Firm specializing in installing work specified in this Section acceptable to manufacturer with experience on at least 5 projects of similar nature in past 3 years.
- B. Pre-Installation Meetings
 1. Convene pre-installation meeting prior to commencing work of this Section.
 2. Coordinate work in this Section with work in related Sections. Coordinate work with plumbing and electrical rough-in. Ensure orderly and efficient sequencing of installation of interdependent trades, construction elements, and include provisions for future work.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials and manufactured products only when the area is ready for installation, broom clean, totally enclosed, and the relative humidity is 50% or less at 70 degrees F.
- B. Storage and Protection: Store materials in a dry secure place. Protect from weather, surface contaminants, construction traffic, and other potential damage.

1.6 MAINTENANCE DATA

- A. Provide cleaning and maintenance information. Include hardware adjustment information.

PART 2 PRODUCTS

2.1 LUMBER

- A. Lumber: Conform to PS 20; Premium Grade in accordance with WII/AWI Architectural Woodwork Standards, Section 3. Dimensions as shown on drawings. Properties as follows:
 1. Moisture Content: Kiln dried; moisture content 6% to 12%.

2. Wood Species:

Use	Species
Framing, internal construction.	Douglas Fir

2.2 WOOD BASED PANELS

- A. Formaldehyde emissions of wood-based panels shall not exceed limits established by the Department of Housing and Urban Development (HUD) and 24 CFR, Section 3208.308. Products containing urea-formaldehyde resins shall not be allowed.
- B. Softwood Plywood: Veneer-core plywood; conforming to PS 1, Exposure 1, Grade A-A, Group 1. Nominal thickness shall be as indicated in this specification and as shown on the drawings.
- C. Particleboard: Meets or exceeds ANSI A208.1, Class M-2, minimum 45 lbs/ft³ (720 kg/m³).
- D. Medium Density Fiberboard (MDF): Meets or exceeds ANSI A208.2, Class SDF, minimum 45 lbs/ft³ (720 kg/m³).
- E. Hardboard: ANSI 135.4, Class 1 – Tempered; smooth-one-side (S1S), minimum 60 lbs/ft³ (960 kg/m³).
- F. Thermally Fused Melamine: Thermoset decorative overlays pre-laminated to substrate (hardboard, particleboard, or MDF as specified in this Section) by thermal fusion; performance characteristics equal to a general purpose grade or liner grade high pressure laminate as per NEMA LD3.

2.3 PLASTIC LAMINATE

- A. Manufacturers:
 - 1. Acceptable Manufacturers:
 - a. Pionite Decorative Surfaces
 - b. Formica Corporation
 - c. Wilsonart Americas
 - d. Or accepted equal.
- B. High-Pressure Decorative Laminates: NEMA LD3; grades and thickness as follows:

Use/Application	NEMA LD3 Grade	Min. Thickness
Horizontal surface where post-forming is not required.	HGS or HGL	0.048 inch ± 0.005 inch (1.22 mm ± 0.127 mm)
Exposed vertical surfaces of casework components where post-forming is not required.	VGS	0.028 inch ± 0.004 inch (0.71 mm ± 0.012 mm)
Exposed vertical surfaces of casework components where post-forming is required for curved surfaces.	VGP	0.028 inch ± 0.004 inch (0.71 mm ± 0.012 mm)
Cabinet liner.	CLS	0.020 inch (0.51 mm)
Backing sheet. Provide at backside of plastic laminated panel substrates to enhance	BK	0.020 inch (0.51 mm)

dimensional stability where laminate finish is applied to only one surface.		
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- C. Color as selected by Architect from manufacturer's full range of colors and/or as indicated on the Finish Schedule.

2.4 SOLID SURFACING

- A. Manufacturers and Products:
 - 1. Acceptable Manufacturers and Products:
 - a. Corian Solid Surfaces
 - b. LG Hausys America, Inc., Product: Hi-Macs.
 - c. Aristech Surfaces LLC, Product: Avonite Solid Surfacing.
 - d. Wilsonart Americas, Product: Gibraltar Solid Surface.
 - e. Or accepted equal.
- B. Solid Surfacing: Non-porous homogeneous blend of acrylic or polyester alloys and fillers creating a solid surfacing material. Color and pattern shall extend throughout the material; 1/2 inch thick.
 - 1. Provide countertops with integral sink bowls fabricated from solid surfacing material; sizes, dimensions, and configurations as indicated on Drawings.
 - 2. Provide countertops fabricated from solid surfacing material; sizes, dimensions, and configurations as indicated on Drawings.
- C. Colors as indicated on Drawings.
- D. Solid Surfacing Accessories:
 - 1. Joint Adhesive: Manufacturer's standard 2-part adhesive kit to create inconspicuous non-porous joints, with a chemical bond.
 - 2. Panel Adhesive: Manufacturer's standard neoprene-based panel adhesive.
 - 3. Sealant: Manufacturer's standard mildew resistant, FDA and UL recognized silicone sealant in color matching or clear formulations.

2.5 ACCESSORIES

- A. Edge Banding: PVC vinyl; 0.125 inch (3 mm) thick by 15/16 inch (23.8 mm) wide. Color and pattern shall closely match exposed door and drawer front laminate color and pattern as accepted by Architect.
- B. Vinyl Countertop Edge: PVC vinyl; 0.125 inch (3 mm) thick. Color and pattern shall closely match countertop laminate color and pattern as accepted by Architect.
- C. Fasteners: Nails, screws, and other fasteners of size and type best suitable for the purpose. Staples, screws or T-nails not permitted at exposed surfaces. Staples and nails not permitted in casework joinery.
- D. Adhesives, Caulks, and Sealants:
 - 1. Adhesives and sealants shall meet VOC requirements of local Air Quality Management District.
 - 2. Adhesives shall be selected for their ability to provide a durable, permanent bond and shall take into consideration such factors as materials to be bonded, expansion and contraction, bond strength, fire rating, and moisture resistance.
 - 3. Wood Joinery: CS 35-61 Type II (water-resistant). Shall withstand cold-soak tests specified in PS 51-71.

4. Laminate Adhesive: Water-based contact adhesive, type recommended by plastic laminate manufacturer.
5. Caulk: 100% clear silicone – use to fill voids and joints between laminated components and adjacent surfaces.
6. Sealant: Mold and mildew resistant; type and composition recommended by substrate manufacturer to provide a moisture barrier at sink cutouts and other locations where unfinished substrate edges may be subjected to moisture.

2.6 CABINET HARDWARE

- A. Hardware shall be furnished and installed as required to provide for a complete and operable casework installation. All hardware shall conform to ANSI/BHMA 156.9 Grade 2, except where a higher grade is specified.
- B. Manufacturers:
 1. Acceptable Manufacturers:
 - a. Accuride International Inc.
 - b. Blum Inc.
 - c. C.R. Laurence Co., Inc.
 - d. Claridge Products & Equipment, Inc.
 - e. Doug Mockett & Company, Inc.
 - f. Gordon Aluminum Industries, Inc.
 - g. Häfele America Co.
 - h. Hettich America L.P.
 - i. Humanscale
 - j. Allegion/Ives
 - k. Knappe & Vogt Manufacturing Company
 - l. CompX International Inc. (formerly National Cabinet Lock)
 - m. Rockford Process Control
 - n. Workrite Ergonomics, Inc.
 - o. Or accepted equal
- C. Hardware shall be furnished and installed as required to provide for a complete and operable casework installation. All hardware shall conform to ANSI/BHMA 156.9 Grade 2, except where a higher grade is specified.
 1. Pulls: Doug Mockett & Co., Type DP128 Round Top Pulls, stainless steel.
 2. Hinges: RPC 456-26D (Dull Chrome).
 3. File and Drawer Slides: Accuride Model No. 3832, 100 lb., full extension, ball bearing, rail mount.
 4. Adjustable Shelf Supports: Hettich #50.016.721 Cadmium Plated Steel Sekura clips with earthquake pin conforming to ANSI/BHMA A156.9 Grade 1 requirements.
 5. Countertop Supports: U.S. Futaba, Inc. Workstation Bracket. Color: Black
 6. Locks: CompX National C8053-14A at doors, C8055-14A at drawers, and D8838 gang lock with core plug. All casework locks and keying shall match facility's casework needs and keying system. Locks shall be keyed in groups per functional operations.
 7. Cable Grommets: Doug Mockett & Co.: Type EDP, 2-1/2" diameter minimum, color: black.
 8. Monitor Arm Supports at Central Control: Humanscale Model M8 with crossbar, bolt-through mount.
 9. Wire Management: Doug Mockett & Co.: Style WM15A sections to underside of countertop.
 10. Elbow Catch: Ives, in chrome finish (typical at pairs of doors with lock).
 11. Pullout Keyboard: Workrite Model #2170-22TG pull-out adjustable arm with Model #185 ultra-thin leatherite platform.
 12. Sliding CPU Holder: Humanscale #CPU 555.

13. Aluminum Extrusions: Gordon; trim and reveals as indicated on drawings.

2.7 FABRICATION

- A. Fabricate and assemble casework components at the shop site to the maximum extent possible. Construction and fabrication of cabinets and their components shall meet or exceed WI grade requirements as indicated in this Section.
- B. Closely fit casework at site. Provide filler inserts and trim where necessary, scribe for a tight fit.
- C. Provide cutouts for inserts, grommets, and fittings. Install grommets where indicated on the drawings after site verification of locations and dimensions. Seal surfaces of cut edges.
- D. Plastic Laminates:
 - 1. Apply plastic laminate in full uninterrupted sheets, consistent with manufactured sizes.
 - 2. Fit corners and joints hairline. Slightly bevel arises.
 - 3. Secure plastic laminated panels with concealed fasteners.
 - 4. Apply laminate backing sheets to reverse side of panels with high-pressure decorative laminates on one face.

E. Sheet Materials Application:

Use/Application	Thickness	Wood-Based Panel
Casework carcass.	Min. 3/4 inch (19 mm)	Plywood, Particleboard, or MDF
Doors and drawer false fronts.	3/4 inch (19 mm)	Plywood, Particleboard, or MDF
Drawer box. Sides, backs, & sub-fronts. Bottom.	Min. 1/2 inch (12 mm), Max. 5/8 inch (16 mm)	Plywood, Particleboard, or MDF
	Min. 1/4 inch (6 mm)	Hardboard or MDF
Cabinet backs.	Min. 1/2 inch (12 mm)	Hardboard or MDF
Laminate clad countertops.	Min. 3/4 inch (19 mm)	Plywood, Particleboard, or MDF
Shelves: up to 32 inch (812 mm) span.	Min. 3/4 inch (19 mm)	Plywood, Particleboard, or MDF
Shelves: 32 inch up to 49 inch (812 up to 1244 mm)	Min. 1 inch (25 mm)	Plywood

F. Casework Carcass:

- 1. Glue frame components together. Brace top corners, bottom corners and cabinet bottoms with hardwood blocks, or metal or plastic braces.
- 2. Joinery Method: Acceptable joinery methods shall be as follows:
 - a. Tops, exposed ends, and bottoms:
 - 1) Steel European assembly fasteners 1-1/2 inches (37 mm) from end, 5 inches (128 mm) on center. Fasteners shall not be visible on exposed parts.
 - 2) Doweled and glued under pressure – approximately 4 dowels per 12 inches (300 mm) of joint.
 - 3) Stop dado, glued under pressure, and either nailed, stapled or screwed. Fasteners shall not be visible on exposed parts.
 - 4) Spline or biscuit and glued under pressure.

- b. Cabinet backs (wall hung cabinets):
 - 1) Wall hung cabinet backs must not be relied upon to support the full weight of the cabinet and its anticipated load for hanging/mounting purposes. Method of back joinery and hanging/mounting mechanism should transfer the load to case body members.
 - 2) Fabrication method: Full bound, capture in grooves on cabinet sides, top, and bottom. Cabinet backs for floor standing cabinets shall be side bound, captured in grooves, glued and fastened to top and bottom.

- G. Drawer Assembly:
 - 1. Drawer box with drawer false front.
 - 2. Acceptable joinery methods:
 - a. Multiple dovetail (all corners) or French dovetail front/dadoed back, glued under pressure.
 - b. Doweled, glued under pressure.
 - c. Lock shoulder, glued and pin nailed.
 - d. Bottoms shall be set into sides, front, and back, 1/4 inch (6 mm) deep groove, with a minimum 3/8 inch (9 mm) standing shoulder.
 - 3. File Drawers: Unless otherwise indicated, direction of file folders shall be parallel to drawer door. Provide adequate, clear inside dimensions for hanging file folders. Minimum clear inside drawer dimensions shall be as follows:
 - a. Letter size file folders: Minimum 13-1/4 inches wide by 10-1/2 inches high.
 - b. Legal size file folders: Minimum 16-1/4 inches wide by 10-1/2 inches high.

- H. Shelving:
 - 1. Fixed shelves: Dadoed or doweled into cabinet sides.
 - 2. Adjustable shelves: 0.197 inch (5 mm) bore holes at 1-1/4 inch (32 mm) on center.

- I. Laminate Countertops and Backsplash:
 - 1. Edge style: PVC edge banding.
 - 2. Mechanically fasten back splash to countertops at minimum 16 inch on center.
 - 3. Substrate shall be moisture-resistant where countertops receive sinks, lavatories, or are subject to liquids.

2.8 FINISH

- A. Finish – Laminated Casework:
 - 1. Drawer box: Thermally fused melamine.
 - 2. Semi-exposed surfaces (as defined in WI Manual of Millwork Section 15):
 - a. Cabinet with doors: Thermally fused melamine.
 - b. Cabinets with open shelves: High-pressure decorative laminate.
 - 3. Exposed surfaces (as defined in WI Manual of Millwork Section 15): High-pressure decorative laminate with PVC edge banding.
 - 4. Doors and drawer false fronts: High-pressure decorative laminate with PVC edge banding.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify field measurements, dimensions, location and layout.
- B. Verify location and sizes of utility rough-in associated with work of this Section.
- C. Verify adequacy of backing and support framing.

- D. Report unacceptable conditions to the Project Manager. Begin installation only when unacceptable conditions have been corrected.

3.2 INSTALLATION

- A. Install in accordance with accepted shop drawings and with applicable WI grade requirements as indicated in this Section.
- B. Install fabricated assemblies, level, plumb, square, and true to line, in locations as shown on the drawings. Attach and anchor securely to the floor and walls with mechanical fasteners appropriate for the substrate.
- C. Use concealed fasteners to attach and secure casework components, countertops, and plumbing fixtures.
- D. Carefully scribe casework abutting other components with a maximum gap of 1/32 inch. Do not use additional overlay trim for this purpose.
- E. Install solid surfacing per manufacturer's instructions.
- F. Install cable grommets in countertops at all casework knee-spaces and where shown on the drawings.

3.3 ADJUSTING

- A. Adjust moving or operating parts for smooth, uniform operation.
- B. Drawer slides shall be adjusted such that the drawer does not act as the stop.

3.4 CLEANING

- A. Clean as recommended by manufacturer. Do not use materials or methods which may damage finish surface or surrounding construction

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes furnishing all materials, labor, equipment, and related services necessary to supply and install architectural glass fiber reinforced plastic (FRP) panels and in compliance with applicable codes.

1.2 REFERENCES

- A. ASTM International (ASTM)
 - 1. D790 - Standard Test Methods of Flexural Properties of Unreinforced and Reinforced Plastics
 - 2. D638 - Standard Test Method For Tensile Properties of Plastics
 - 3. D256 - Standard Test Methods For Determining the Izod Pendulum Impact Resistance of Plastics.
 - 4. D570 - Standard Test Method For Water Absorption of Plastics
 - 5. D2583 - Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor
 - 6. E84 - Standard Test Method for Surface Burning Characteristics of Building Materials

1.3 ACTION SUBMITTALS

- A. Product Data: Submit product data sheets for each specified product.
- B. Shop Drawings: Submit drawings for approval showing plans, sections, details, joint treatment, reinforcing, fastening devices and the relation of the FRP parts to the surrounding construction.
- C. Samples: Submit a minimum of 3 flat samples of FRP material for each color and texture indicated.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications:
 - a. Manufacturer shall have a minimum of 10 years experience having successfully supplied FRP parts for other projects similar in scope and complexity for the work of this Contract.
 - b. Manufacturer shall have a minimum of 10 years' experience using 3D modelling software and CNC machines for the creation of master patterns used to make molds for fabricated FRP components.
- B. Installer Qualifications: Installer shall have a minimum of 5 years' experience having successfully completed projects similar in scope and complexity for the work of this Contract.
- C. Substrates to accept FRP parts shall be installed straight and true within 1/8 in. in 8 linear ft. (3mm in 2500mm) and shall be free of obstructions and interference that prohibits the correct alignment and attachment of the FRP parts.
- D. Where the work schedule permits, confirm dimensions and site conditions prior to manufacturing FRP parts specified in this section. Any deviations from the design conditions or dimensions to be provided to the manufacturer for inclusion in the shop drawings.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Handle and transport FRP parts to avoid damage. Place non-staining resilient spacers between parts and support parts during shipment.
- B. Parts shall be kept clean and dry and stored to prevent distortion, warping, and other physical damage in accordance with the manufacturer's recommendations.
- C. Place stored panels so part identification labels are clearly visible.
- D. The installing contractor is responsible for damage to the FRP parts after delivery.

1.6 WARRANTY

- A. Manufacturer Warranty: Provide manufacturer's standard product warranty.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. Formglas Products Ltd.
- B. Stromberg
- C. Or accepted equal.

2.2 GLASS FIBER REINFORCED PLASTIC (FRP) FABRICATIONS

- A. Fabrications: Molded FRP parts shall have a Class 1 (or A) fire rating with a Flame Spread Rating: ≤ 25 ; Smoke Development Index: ≤ 450 , when tested in accordance to ASTM E84
- B. Gelcoat: The FRP parts shall have an ultra violet stabilized polyester gelcoat with a minimum thickness of 15-20 mil.
- C. Back-up Laminate: Glass reinforcement shall consist of a glass fiber polyester composite with 25-30% glass fiber content.
- D. All reveals, set backs or returns to have a minimum of 3° draft angle.
- E. All outside corners to have a minimum 1/8" (3mm) radius.
- F. Identification: All FRP parts to have labels affixed to the back individually identifying them with the same part numbers used on the shop drawings.

2.3 PHYSICAL PROPERTIES

- A. Matrix: Polyester Resin
 - Shell thickness: 3/16" (4.5 mm) nominal
 - Edge thickness: 3/4" (19 mm) typical
 - Density: ~110 lb/ft³ (1675 kg/m³)
 - Weight: 1³/₄ - 2¹/₄ lb/ft² (8.5-11 kg/m²)
 - Glass Fiber: 25-30% typical
 - Embedments: Core mat, or other reinforcements as required
 - Color: As specified
 - Surface: Smooth, unless otherwise specified

Flexural Strength (ASTM D790): 32,000 psi (221 MPa)
Tensile Strength (ASTM D638): 15,950 psi (110 MPa)
Compressive Strength (ASTM D695): 33,100 psi (228 MPa)
Modulus of Elasticity (ASTM D790): 1,080,000 psi (10.5Gpa)
Impact Resistance (ASTM D256): 12 ft·lbf/in. (643 J/m)
Hardness (ASTM D2583): 44 Barcol
Coefficient of Linear Thermal Expansion (ASTM D696): 2.73×10^{-5} in/in/°F
(1.5×10^{-6} in/in/°C)
Heat Deflection: > 513°F (285°C)
Taber Abrasion (ASTM D4060): 0.87 mg weight loss after 500 cycles
Water Absorption (ASTM D570): 0.3%
Nail push-through: 1050 lbf (4,670 N)
Surface Burning Characteristics (ASTM E84):
Flame Spread: ≤ 25 (Class A)
Smoke Development: ≤ 450 (Class A)

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Site Conditions: Verify the conditions for compliance with the requirements including environmental conditions, installation tolerances and other conditions affecting the installation and performance of FRP parts. Any unsatisfactory conditions shall be corrected prior to installation.
- B. Field Dimensions: Field dimensions are to be verified including those not shown on the drawings. Details of any changes required must be incorporated into the manufacturer's shop drawings prior to commencing the manufacture of the FRP parts.

3.2 PREPARATION

- A. Substrate: Substrates to accept FRP parts, provided by others, shall be installed straight and true within 1/8 in. in 8 ft. (3mm in 2500mm) and shall be free of obstructions and interference that prohibits correct attachment of FRP parts.
- B. Structural framing members and bearing surfaces, provided by others, shall be true and level, of the proper size, spacing and design for the intended use and shall be sufficient to properly support the installed FRP parts.

3.3 INSTALLATION

- A. Install in accordance with the manufacturer's instructions, contract documents and shop drawings.
- B. The Installing contractor to provide all support brackets, connection hardware, adhesives, and other accessories required for the proper installation of the FRP fabrications in accordance to the manufacturer's requirements and applicable building codes.
- C. Position and secure FRP parts carefully into place plumb, level and aligned with adjacent parts, shimmed where necessary.
- D. Anchors and fasteners to be type 304 stainless steel where exposed; hot dipped galvanized steel where unexposed.

- E. Provide temporary supports or bracing as required to maintain position, stability and alignment of parts until permanently secured.
- F. Installing contractor to repair and patch holes or defects to match the original work. Provide joint spacing between parts as detailed for expansion and the application of joint treatment materials.
- G. Provide joint spacing between parts as detailed in the approved drawings for expansion and the application of joint treatment materials.

3.4 JOINT PROTECTION

- A. Caulk all joints with a low modulus exterior elastomeric sealant recommended by the manufacturer. Color of caulk to be selected by the Architect. (If joint treatment follows under a separate section of this contract, this does not apply).

3.5 CLEANING AND PROTECTION

- A. Perform cleaning procedures, if necessary, according to FRP manufacturer's written instructions. Take precautions to prevent damage to FRP surfaces and staining of adjacent materials.

END OF SECTION

PART 1 GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Self-adhesive elastomeric sheet membrane waterproofing underlayment at metal roofing panels.

- B. References:
 - 1. Unless otherwise noted, standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes as of the date of issue of this Project Manual.
 - 2. American Society of Testing Materials (ASTM):
 - a. ASTM D412-16: Standard Test Methods for Vulcanized Rubber and Thermoplastic and Thermoplastic Elastomers – Tension.
 - b. ASTM D903-98(2017): Standard Test Method for Peel or Stripping Strength of Adhesive Bonds.
 - c. ASTM D1970/D1970M-19: Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection.
 - d. ASTM D3767 - 03(2014): Standard Practice for Rubber—Measurement of Dimensions.
 - e. ASTM E96/E96M-16: Standard Test Methods for Water Vapor Transmission of Materials.
 - f. ASTM G90-17: Standard Practice for Performing Accelerated Outdoor Weathering of Materials Using Concentrated Natural Sunlight.
 - 3. National Roofing Contractors Association (NRCA):
 - a. Waterproofing Manual.

1.2 SUBMITTALS

- A. Manufacturer's Instructions and Product Information.
 - 1. Furnish manufacturer's printed instructions for the installation of membranes, including procedures and materials for splicing and bonding.

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with requirements of authorities having jurisdiction and applicable codes at the location of the project.

- B. Manufacturer: Minimum 10 years' experience producing roofing underlayment.

- C. Installer: Minimum 2 years' experience with installation of similar underlayment. Installation firm shall be typically engaged in this business and approved by the material manufacturers. All work shall be performed by qualified applicators working under an experienced supervisor.

- D. Manufacturer's Representation during Installation: A qualified representative of the membrane manufacturer shall be present periodically during the work on the waterproof membrane system to assure compliance with the specifications and recommendations of the manufacturer.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Materials shall be delivered to the job site in original unbroken packages bearing the manufacturer's label. Material shall be stored above the ground in a dry location. Containers shall be stored in such a manner as to prevent damage.
- B. Cover materials and store in dry condition between temperatures of 40 and 90 degrees F (5 and 32 degrees C). Install within one year of date of manufacture. Do not store at elevated temperatures which will reduce the shelf life of the product.

1.5 JOB AND ENVIRONMENTAL CONDITIONS

- A. Job Conditions: The Membrane Waterproofing Contractor shall acquaint himself with all conditions and general construction methods and sequence to be employed. No extras will be permitted for his failure to do so.
- B. Environmental Conditions
 - 1. Temperature: Surface temperature shall not be higher than 90 degrees F and no lower than 40 degrees F during application of membrane.
 - 2. Weather: Do not apply during periods of precipitation or when rain is expected for period of application, and for at least three hours following application.
 - 3. Ventilation: Provide positive ventilation to all areas not subject to natural ventilation during application and curing periods.

1.6 WARRANTY

- A. Membrane waterproofing shall be warranted for two years from the date of filing Notice of Completion against all defects in materials and workmanship. Warranty shall also cover damage due to leaks, defective materials and installation.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design: GCP Applied Technologies, Inc.
 - 1. Grace Ice and Water Shield HT.
 - 2. Perm-A-Barrier WB Primer.
- B. Carlisle SynTec Systems
- C. W. R. Meadows
- D. Pecora Corporation
- E. Or accepted equal.

2.2 MATERIALS

- A. Self-Adhering Sheet Membrane Roof Underlayment:
 - 1. Material: Cold applied, self-adhering membrane composed of a rubberized asphalt adhesive and inter-wound with a disposable release sheet. Provide an embossed, slip resistant surface on a high performance film with UV barrier properties.
 - 2. Membrane Thickness: 40 mils (1.02 mm) per ASTM D3767 Method A.
 - 3. Membrane Tensile Strength: MD 33 lbf/in, CD 31 lbf/inch per ASTM D412 Die C

Modified.

4. Membrane Elongation: 250% per ASTM D412 Die C Modified.
5. Low Temperature Flexibility: Unaffected at minus 20 degrees F (minus 29 degrees C) per ASTM D1970.
6. Maximum Permeance: 0.05 perms (2.9 ng/sgms Pa) per ASTM E96.
7. Maximum Material Weight Installed: 0.22 pounds/sq. ft. (1.1 kg/sqm).
8. Service Temperature: 240 degrees F (115.6 degrees C) per ASTM D1204
9. Adhesive: Rubberized asphalt adhesive containing post-consumer recycled content, contains no calcium carbonate, sand or fly ash.
10. Compatibility: Suitable for use under all types of sloped roofing.
11. Adhesive: Rubberized asphalt adhesive containing post-consumer recycled content, containing no calcium carbonate, sand or fly ash.
12. Exposure: Can be left exposed for a maximum of 120 days from date of installation per ASTM G90.
13. Primer: Water-based primer by sheet waterproofing manufacturer.

2.3 ACCESSORIES

- A. Primer: VOC compliant, low odor, water-based primer which imparts a high tack finish on the treated substrate.

PART 3 EXECUTION

3.1 INSPECTION

- A. Examine surfaces to receive membrane waterproofing to assure that they are smooth, dry and free of foreign material, moisture and unevenness which would prevent the execution and quality of application of the membrane waterproofing as specified.
- B. Do not proceed with application of waterproofing systems until defects are corrected.

3.2 PREPARATION OF SURFACES

- A. Surfaces shall be dry, clean, smooth and free from projections or holes that may cause puncture of membrane. Substrate shall be absolutely surface dry for proper adhesion of membrane. Minimum curing time for concrete shall be seven days.
- B. Cleaning: Clean surfaces to remove all curing compounds, loose dirt, moisture, grease, dust and other foreign material.

3.3 APPLICATION OF PRIMER

- A. Apply primer over sheathing per manufacturer's recommendations at a rate of 250 - 350 square feet per gallon.
- B. Allow primer to fully dry prior to start of membrane installation.

3.4 APPLICATION OF MEMBRANE

- A. Install membrane per manufacturer's recommendations.
 1. Schedule installation such that membrane is covered by roofing within the published exposure limit of the underlayment.
 2. Do not install membrane on wet or frozen substrates.
 3. Install when surface temperature of substrate is a minimum of 40 degrees F (5 degrees

- C) and rising.
4. Remove dust, dirt, loose materials and protrusions from substrate surface.
 5. Install membrane on clean, dry, continuous substrate. Fill voids and damaged or unsupported areas prior to installation.
 6. Install membrane such that all laps shed water. Work from the low point to the high point of the roof at all times. Apply the membrane in valleys before the membrane is applied to the eaves. Following placement along the eaves, continue application of the membrane up the roof. Membrane may be installed either vertically or horizontally after the first horizontal course.
 7. Side laps shall be minimum 3-1/2 inches (89 mm) and end laps shall be minimum 6 inches (152 mm) following lap lines marked on membrane.
 8. Patch penetrations and damage using manufacturer's recommended methods.

3.5 CLEANING AND PROTECTION

- A. At the completion of the work of this section, all surfaces and areas adjoining the membrane shall be left in a clean condition. All cartons, pails and equipment shall be removed from the premises.
- B. Clean any stains on materials that would be exposed in the completed work.
- C. Protection: Protect from damage during construction operations and installation of roofing materials. Promptly repair any damaged or deteriorated surfaces.
- D. Repair minor damage to eliminate all evidence of repair. Remove and replace work which cannot be satisfactorily repaired in the opinion of the Project Manager.
- E. Provide temporary protection to ensure work being without damage or deterioration at time of final acceptance. Remove protective film and re-clean as necessary immediately before final acceptance.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Room temperature vulcanizing (RTV) silicone rubber water repellent and anti-graffiti coatings.

1.2 REFERENCES

- A. Unless otherwise noted, standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes as of the date of issue of this Project Manual.
- B. Referenced Standards:
 - 1. ASTM C793 – Standard Test Method for Effects of Laboratory Accelerated Weathering on Elastomeric Joint Sealants.
 - 2. ASTM D412 – Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers – Tension.
 - 3. ASTM D746 – Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
 - 4. ASTM D2240 – Standard Test Method for Rubber Property – Durometer Hardness.
 - 5. ASTM E96 – Standard Test Methods for Water Vapor Transmission of Materials.

1.3 SUBMITTALS

- A. Product Data: Submit the following:
 - 1. Manufacturer's descriptive literature and product data sheets.
 - 2. MSDS.
- B. Quality Assurance/Control Submittals:
 - 1. Submit manufacturer qualifications information.
 - 2. Submit applicator qualifications information.
 - 3. VOC content limits certification.
 - 4. Provide narrative description of protection of surrounding areas and non-masonry surfaces, surface preparation, application, and final cleaning.
 - 5. Manufacturer's application instructions
 - 6. Manufacturer's field reports.
- C. Closeout Submittals:
 - 1. Manufacturer's warranty certificate.
 - 2. Cleaning and maintenance data.

1.4 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Manufacturer Qualifications: Firm specializing in manufacturing products specified in this Section with a minimum 10 years experience.
 - 2. Applicator Qualifications: Firm specializing in installing work specified in this Section acceptable to manufacturer with experience on at least 5 projects of similar nature in the past 3 years of similar nature. Provide a complete list of completed projects, including project name and location, names of Contractor and Architect including contact information, and description of products, substrates, and method of application.

- B. Regulatory Requirements:
 - 1. Comply with the local Air Quality Management District's (AQMD) rules and regulations.
 - 2. Provide products that meet requirements of local AQMDs for volatile organic compounds (VOC).
- C. Certifications:
 - 1. VOC Content Limits Certification: Submit certification that coating product complies with local air quality management district's regulations and prescribed requirements for volatile organic compounds (VOC).
- D. Field Sample (Test Panel):
 - 1. Before full-scale application, review manufacturer's product data sheets to determine the suitability of each product for the specific surfaces. Apply coating to test panels to determine appropriate strength, coverage rates, compatibility, effectiveness, surface preparation, application procedures and desired results.
 - 2. Apply coating to test panels as directed by Architect, minimum 48 inches wide by 48 inches high for each type of substrate, in accordance with manufacturer's written instructions. Allow 24 hours or until panels are thoroughly cured before evaluating final appearance and results. Do not begin full-scale application until test panels are inspected and accepted by the Project Manager.
 - 3. Allow coating to cure at least 7 days prior to testing using low-pressure tube test (RILEM) or masonry absorption test (MAT) methods.
- E. Tests:
 - 1. Test panel: County appointed testing laboratory shall perform tests on test panels using low-pressure tube test (RILEM) or masonry absorption test (MAT) methods.
 - 2. Executed work: County appointed testing laboratory shall perform two tests for each type of substrate on executed work at randomly selected areas designated by Project Manager.
 - 3. County shall pay for these tests; however, retesting required because of non-conformance shall be paid for by the Contractor.
- F. Pre-Installation Meetings:
 - 1. Convene pre-installation meeting prior to commencing work of this Section. Require attendance of parties directly affecting work of this Section including Contractor, Project Manager, Architect, applicator, and manufacturer's representative. Review environmental requirements, test panel procedures, protection of surrounding areas and non-masonry surfaces, surface preparation, application, field quality control, final cleaning, coordination with other work, and extended warranty requirements.
 - 2. Coordinate work in this Section with work in related Sections.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products in manufacturer's original containers, dry and undamaged, with seals and labels intact.
- B. Storage and Protection: Store containers in a cool, dry place. Keep away from sparks and open flame. Store and handle materials in accordance with manufacturer's written instructions.

1.6 ENVIRONMENTAL REQUIREMENTS

- A. Temperature: Coating product may be applied at any temperature, providing that there is no frozen moisture present in the substrate. When applied at temperatures below 40 degrees F, the product may cure at a slower rate. Optimal ambient temperature for applying product is

40 to 95 degrees F (5 to 35 degrees C).

- B. Do not apply material if the substrate is wet or contains frozen moisture. Allow substrate to dry for a minimum of 48 hours after rain or power washing.
- C. Do not apply material during inclement weather or if precipitation is expected within 12 hours.
- D. Do not use spray methods of application under windy conditions.

1.7 WARRANTY

- A. Provide manufacturer's extended warranty – 5 years horizontal and 10 years vertical warranty.
- B. Prior to applying coating, review and comply with manufacturer's warranty processing requirements – do not proceed until warranty processing requirements have been met.

1.8 OPERATIONS AND MAINTENANCE DATA

- A. Provide cleaning and maintenance data.

PART 2 PRODUCTS

2.1 MANUFACTURERS AND PRODUCTS

- A. Acceptable Manufacturers and Products:
 - 1. Professional Products of Kansas, Inc.
 - a. Professional Water Sealant Super Strength (15% Silicone Rubber). Provide one coat where water repellent coating is required and two coats where anti-graffiti coating is required.
 - 2. Prosoco, Inc.
 - 3. or accepted equal.

2.2 WATER REPELLENT/ANTI-GRAFFITI COATING

- A. Penetrating sealer formulated using RTV silicone rubber. Penetrates without altering the natural appearance of the substrate. Inorganic; not affected by ultraviolet rays, ozone, salt spray, and acid rain. Breathable; allows moisture-vapor to escape while preventing liquid penetration. Flexible; bridges hairline cracks and allows for building movement.
- B. Properties:
 - 1. Perm Rate (ASTM E96, Method B): 7.06.
 - 2. Durometer Hardness (ASTM D2240, Shore A): 27.
 - 3. Tensile Strength (ASTM D412): 320 MPa.
 - 4. Elongation (ASTM D412): 400%.
 - 5. Brittle Point (ASTM D746): -100 degrees F (-73 degrees C).
 - 6. Accelerated Weathering (ASTM C793): No change after 4000 hours.

PART 3 EXECUTION

3.1 EXAMINATION

3/2023

- A. Examine substrate conditions to determine that conditions are acceptable to receive coating. Verify the following:
 - 1. The required joint sealants have been installed.
 - 2. Masonry and mortar has cured a minimum of 28 days.
 - 3. Surface to be treated is clean, dry, and contains no frozen moisture.
 - 4. Environmental conditions are appropriate for application.
- B. Report unacceptable conditions to Project Manager. Begin installation only when unacceptable conditions have been corrected.

3.2 PREPARATION

- A. Protection
 - 1. Protect surrounding areas such as, but not limited to, glass, landscaping, building occupants, pedestrians, vehicles, and non-masonry surfaces during the work from contact with coating.
 - 2. Take special precautions to prohibit fumes from entering the building being treated. Cover and turn-off ventilation systems and fresh air intakes.
- B. Surface Preparation
 - 1. Clean all dirt, oil, grease, mold, mildew, efflorescence, or any other coating or material from surfaces that interfere with penetration, performance, adhesion, or aesthetics of coating. Rinse thoroughly, using pressure water spray to remove cleaner residues. Allow surfaces to dry completely before application of coatings.
 - 2. Repair, patch, and fill all cracks, voids, defects, and damaged areas in surface as accepted by Project Manager. Allow repair materials to cure completely before application of coatings.
 - 3. Seal all open joints.
 - 4. Allow masonry surfaces to cure for a minimum of 28 days before application of coating.

3.3 APPLICATION

- A. All exterior masonry surfaces shall receive water repellent coating. Apply a second coat for anti-graffiti resistance at all exterior masonry surfaces to a height of ten feet minimum above grade. Terminate the second coat at a horizontal mortar joint line consistent along building faces.
- B. Apply coatings to substrates in accordance with manufacturer's written instructions, environmental requirements, and application procedures determined from test panel results accepted by Project Manager.
- C. Apply to clean, dry, cured, and properly prepared surfaces.
- D. Apply material as shipped by manufacturer – do not dilute.
- E. Apply material using a high-volume, low pressure, pump-up sprayer (between 40-50 psi), with solvent resistant fittings, foam roller, or brush of natural bristle, or foam.
 - 1. Vertical applications: apply in a flood coat, from top to bottom, being sure to obtain a 4 to 6 inch rundown of product from the point where the spray makes contact with the surface. Work all the way down the building covering the rundown as you go. Avoid excessive overlapping.
 - 2. Horizontal applications: If surface pooling or puddling occurs, back-roll, brush, or broom away excess material. Complete penetration must occur. Avoid excessive overlapping. Material curing on surface may cause whitening or slickness.

3.4 FIELD QUALITY CONTROL

- A. Coating work shall be inspected by Project Manager, Project Inspector, and manufacturer's representative; and compared with accepted test panel.
- B. Manufacturer's Field Services: Provide services of manufacturer's authorized field representative to verify specified products are used; protection, surface preparation, and application of coatings are in accordance with manufacturer's written instructions; and the test panel is accepted by Architect.

3.5 CLEANING

- A. Clean as recommended by manufacturer. Do not use materials or methods which may damage finish surface or surrounding construction.
- B. Upon completion of coating application, remove all equipment, materials and debris, leaving the area in an undamaged and acceptable condition. Dispose of coating containers according to state and local environmental regulations.
- C. Clean, repair, restore, or replace to the satisfaction of Architect, all materials, landscaping, and all non-masonry surfaces damaged by exposure to coatings at no cost to County.

END OF SECTION

PART 1 – GENERAL

1.1 SUMMARY

A. Section Includes:

1. Provide thermal insulation system at exterior walls and acoustic batt insulation at interior walls with accessories as required for complete installation.

1.2 SUBMITTALS

A. Product Data: Furnish manufacturer's literature for each type of insulation.

1. Indicate thermal insulation name and number as included in California Energy Commission's Directory of Certified Material.
2. Submit Underwriter's Laboratory approval numbers for required fire ratings; approvals of other laboratories contingent upon acceptance of applicable authorities.
3. Installation Instructions: Submit manufacturer's installation instructions.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Acceptable Manufacturers:

1. Knauf Insulation
2. Johns Manville
3. Owens-Corning Fiberglas Corp.
4. Certainteed.
5. Or accepted equal.

B. Materials

1. Exterior Wall Batt Insulation within closed wall cavity: R-21 Preformed kraft-faced fiberglass batts at all exterior wood framed walls.
2. Acoustic Batt Insulation at all Interior Walls: R-11 unfaced, u.n.o.
3. Insulation Supports: Galvanized or electroplated steel wire supports with friction attachment to framing.
4. Nails or staples: Steel wire; electroplated; type and size to suit application.
5. Line Wire: Galvanized steel, 19 gauge wire.

6. Wire Mesh: 1 ½" x 17 gauge poultry netting.
 7. Accessories: Furnish as recommended by insulation manufacturer for insulation types, substrates, and conditions involved.
- C. Insulation shall comply with California standards for insulating material. Maximum flame spread rating of 25 and maximum smoke density per 2010 CBC Section 803.
1. Flame Spread/Smoke Density Rating: Maximum 25/450, ASTM E84.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify substrate and adjacent materials are dry and ready to receive insulation; beginning installation signifies acceptance of conditions.
- B. Ensure mechanical and electrical items affecting work are properly placed, complete, and have been inspected prior to commencement of installation.

3.2 INSTALLATION

- A. Install insulation in accordance with manufacturer's instructions.
- B. Cut and trim insulation neatly, to fit spaces.
 1. Backed Insulation: Use insulation free of ripped backs and edges.
- C. Fit insulation tight within spaces and tight to and behind mechanical and electrical services within insulation plane; leave no gaps or voids; maintain integrity of thermal barrier.
- D. Maintain minimum ventilating airspace as required by the Drawings.
- E. Friction fit in place; use tape or friction supports as necessary to assure permanent installation.
 1. Taping: Tape joints and tears in vapor retarder, including joints between insulation and surrounding construction, to ensure vapor-tight installation.
 2. Penetration Supports: Cut or bend pins in locations accessible to maintenance personnel, to eliminate potential hazards from exposed pin points.

END OF SECTION

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Provide Vapor Retarder system for slab-on-grade concrete, including sealing penetrations through vapor retarder.

- B. References:
 - 1. American Society for Testing and Materials (ASTM):
 - a. ASTM D1004-13 Standard Test Method for Tear Resistance (Graves Tear) of Plastic Film and Sheeting.
 - b. ASTM E96/E96M-16 Standard Test Methods for Water Vapor Transmission of Materials.
 - c. ASTM E154/E154M-08a(2019) Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover.
 - d. ASTM E1643-18a Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs
 - e. ASTM E1745 - 17 Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs.
 - f. ASTM F1249 - 13 Standard Test Method for Water Vapor Transmission Rate Through Plastic Film and Sheeting Using a Modulated Infrared Sensor.
 - 2. American Concrete Institute (ACI):
 - a. ACI 302.1R-15 Guide to Concrete Floor and Slab Construction.
 - b. ACI 302.2R-06 Guide for Concrete Slabs that Receive Moisture-Sensitive Flooring Materials.

1.2 SUBMITTALS

- A. Product Data: Submit manufacturer's literature.

1.3 PROJECT CONDITIONS

- A. Do not apply vapor retarder during inclement weather or when air temperature is below 40 degrees F.

1.4 WARRANTY

- A. Provide manufacturer's warranty for materials and workmanship for a period of two years from the date of purchase.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design: Vaporblock Plus VPB20 Under-Slab Vapor / Gas Barrier, Raven Engineered Films
- B. Drago Wrap Vapor Intrusion Barrier (20-mil), Stego Industries, LLC.
- C. Viper Venom Barrier (20-mil Class A Vapor/Gas Barrier), ISI Building Products

- D. Or accepted equal.

2.2 MATERIALS

- A. Vapor Retarder: ASTM E1745, Class A vapor retarder consisting of 20 mil polyolefin film.
 - 1. Permeance: Maximum 0.01 perms, ASTM F1249/E154 tests and ASTM E-96.
 - 2. Resistance to Puncture: Minimum 3500 grams, ASTM D1709, Method B.
 - 3. Tear Resistance: Minimum 8.74 lbs., ASTM D1004.
 - 4. Tensile Strength: Minimum 95 lbs./in., ASTM E154, Section 9, Method D-882, in both directions.
- B. Joint Sealer: Pressure sensitive tape as recommended by vapor retarder manufacturer and providing comparable permeance to vapor retarder.

PART 3 EXECUTION

3.1 PREPARATION

- A. Ensure sleeves, curbs and projections that pass through vapor retarder are properly and rigidly installed.
- B. Ensure substrate is free of projections and irregularities that may be detrimental to proper installation of vapor retarder.

3.2 INSTALLATION

- A. Apply vapor retarder in accordance with manufacturer's recommendations and installation instructions and in accordance with ASTM E1643; comply with most restrictive where conflicts occur.
 - 1. Seal items projecting through vapor retarder with manufacturer's pressure sensitive tape per manufacturer's instructions.
- B. Seams: Minimum 6 inch overlap, sealed with manufacturer's pressure sensitive tape for vapor tight seal.
- C. Lay vapor retarder membrane smooth with no fish-mouths or bunches of material.
- D. Inspect and repair vapor retarder prior to application of concrete slab; tape tears and repair damage with vapor barrier material of similar (or better) permeance, puncture and tensile.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Vapor emission control system for application over concrete slabs indicated to receive finished floor coverings.

1.2 REFERENCES

- A. Unless otherwise noted, standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes as of the date of issue of this Project Manual.
- B. Referenced Standards:
 - 1. ASTM D1308 – Standard Test Method for Effect of Household Chemicals on Clear and Pigmented Organic Finishes.
 - 2. ASTM E96 – Standard Test Methods for Water Vapor Transmission of Materials.
 - 3. ASTM F710 – Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring.
 - 4. ASTM F1869 – Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.
 - 5. ASTM F2170 – Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes.

1.3 DEFINITIONS

- A. The System: Vapor emission control system specified in this Section referred to as “the System” in this Section for brevity.

1.4 SUBMITTALS

- A. Submittal Requirements: Submit product data, test reports, certificates, and manufacturer’s standard warranty.
- B. Submit list of similar projects completed with specified vapor emission control system, with documented evidence of vapor emission rate of 3 lb/1000 sq. ft./24 hrs or less, after system application.
- C. Moisture, pH, and relative humidity test results of concrete slab, certified by a qualified testing agency.

1.5 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Installer Qualifications:
 - a. Installer shall be either manufacturer’s trained personnel; or manufacturer’s factory-trained and certified installer.
 - b. Installer shall have a minimum of 5 years experience in the installation of specified vapor emission control system and shall have worked on a minimum of 5 installations using the same system.
 - 2. Manufacturer Qualifications:
 - a. Minimum 10 years experience in manufacturing water vapor emission control systems, specifically formulated and used for reducing water vapor emissions, and alkalinity control in concrete slabs, without change of system formulation for a minimum period of 5 years at the time of application.

- b. Experience in product application in similar projects requiring vapor emission control at new and existing concrete slabs.
 - 1) Similar projects shall have documented initial water vapor emission rates of 25 lbs/1,000 sq. ft./24 hrs or in excess of 3 lbs/1,000 sq. ft./24 hrs before the System application, and resulted in maintained water vapor reduction rate of 3 lbs/1,000 sq. ft./24 hrs or less, when tested according to ASTM F1869, after the System application.
 - c. Manufacturer shall provide independent laboratory test reports documenting performance of the System as follows:
 - 1) Water Vapor Transmission (Water Method), ASTM E96: Performance of the System shall be documented by an independent testing laboratory, with a minimum of 97 percent vapor transmission reduction for the System, when compared to untreated concrete. Perm rate results shall not exceed 0.1.
 - 2) Alkalinity Test, ASTM D1308: Insensitivity to alkaline environment up to pH 14 in a 14-day test with no effect or degradation of sample.
 - 3. Testing Agency Qualifications: Qualified and experienced agency to perform Moisture, pH, relative humidity (RH), and vapor emission tests, as specified in this Section.
- B. Environmental Requirements: The System shall meet applicable VOC requirements of authorities having jurisdiction at Project site.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver products to the job site in manufacturer's original unopened containers, clearly labeled with the manufacturer's name and brand designation.
- B. Store products in a ventilated dry area, protected from dampness, freezing, and direct sunlight. Products shall not be stored in areas with temperatures in excess of 90 degrees F or below 50 degrees F, or with humidity in excess of 80 percent.

1.7 SITE CONDITIONS

- A. Concrete Curing: New concrete shall be cured for a minimum period of 56 days when concrete with SCM is used.
- B. Enclosures and Environmental Limitations:
 - 1. Prior to testing concrete slabs for vapor emission rates, building shall be fully enclosed, and weather-tight. Interior wet work shall be completed and nominally dry, and work above ceilings completed. Test sites shall be maintained at the same temperature and humidity expected during normal building use.
 - 2. Concrete slabs shall be fully protected, with no water accumulation on the surface.
 - 3. Do not apply the System when ambient temperature is lower than 50 degrees F or higher than 90 degrees, or expected to fall below 50 degrees F or rise above 90 degrees F within 24 hours of the System application, or humidity level is above 80 percent.

1.8 WARRANTY

- A. Provide manufacturer's written warranty for the System, covering system materials, testing, surface preparation, and installation. Additionally, warranty shall cover the cost of floor covering repair or replacement, as acceptable to County and Project Manager, including, but not limited to, removal work, surface preparation, underlayment, floor covering materials, primers, adhesives, and associated installation work.
 - 1. Warranty Period: Ten years, minimum, or the life of finished floor covering, whichever

- comes first.
2. Replacement Cost: In the event of failure of the System during warranty period, manufacturer's warranty shall cover all costs for removal and replacement work including the System and floor covering, up to \$5,000,000 per occurrence.
- B. Manufacturer's warranty exclusion shall be limited to the following:
1. System failure due to topical intrusion of water due to plumbing failure, or other substances entering from the surface.
 2. Seismic damage occurring after installation.
 3. Damage due to removal and demolition work necessitated by replacement of installed floor covering during warranty period.
- C. Warranty shall not exclude cracks visible at the time of installation or "improper System installation."

PART 2 PRODUCTS

2.1 MANUFACTURERS AND PRODUCTS

- A. Vapor Emission Control System:
1. Manufacturer: Koester American Corporation, Vap 1[®] 2000.
 2. MC Ultra by Ardex.
 3. Or accepted equal.

2.2 SYSTEM DESCRIPTION

- A. General: Vapor emission control system shall be warranted to control vapor emissions to 3 lbs/ 1000 sq. ft./ 24 hrs or less, as determined by:
1. Site conditions.
 2. Concrete mix design.
 3. Age of concrete substrate.
 4. Calcium chloride moisture and pH test results.
 5. Relative humidity in the concrete slab.
 6. Compatibility with finished floor covering products.
- B. System Performance: Installed system shall bring pH levels within the range of 8-9, as determined by pH testing, and reduce vapor emission level from 25 lbs/1,000 sq ft/24 hrs to 3 lbs/1,000 sq ft/24 hrs or less in one coat, as determined by calcium chloride testing (regardless of the level of vapor emissions after initial pre-installation testing) at areas indicated to receive a finished floor covering or finish coating.
1. Water Vapor Transmission (Water Method): ASTM E96; performance of the System shall be documented by an independent testing laboratory, with a minimum 97 percent water vapor transmission reduction for the System, when compared to untreated concrete. Perm rate results shall not exceed 0.1.
 2. Alkaline Exposure Testing: ASTM D1308; insensitivity to alkaline environment up to pH 14 in a 14-day test.
 3. Moisture Emission Testing: ASTM F1869; calcium chloride test results of less than 3 lbs/1,000 sq ft/24 hrs after installation of the System.
 4. Relative Humidity Testing: ASTM F2170; the System shall perform as specified with relative humidity test results of 100 percent or less.
 5. Certified acceptance of exposure to continuous topical water exposure after final curing of the System.
 6. Vapor emission control system shall be applied in a single coat, and shall be a stand alone system with no requirements for additional components, such as, sand broadcast for subsequent adhesion of floor covering.

7. Perm rate results shall not exceed 0.1.
- C. System Materials: Two-component epoxy resin system, 100 percent solids, containing specifically formulated chemicals and resins to provide the characteristics and properties listed above, in one coat application. System requiring more than one coat for installation is not acceptable.
- D. Accessories: Concrete repair materials, underlayment, and primers used under vapor emission control system shall be as recommended by or acceptable to the System manufacturer. Underlayment used over the System shall be acceptable to vapor emission control system and floor covering manufacturers.

2.3 MIXING

- A. Use clean containers and mix components thoroughly, in accordance with manufacturer's printed instructions, to obtain a homogeneous mixture. Use a low speed motor less than 400 rpm and a two bladed Jiffy mixing blade only. Do not aerate the mixture. Mix ratios shall be measured by volume.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements and for other conditions affecting performance of the System.
- B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.
- C. Do not begin installation of the System until minimum seven day concrete curing and drying period has passed, after unsatisfactory conditions have been corrected, and after surfaces are dry.

3.2 CONCRETE SLAB TESTING

- A. Testing Schedule: Testing shall be performed by Contractor prior to and after application of the System. Contractor shall provide a testing schedule to Project Manager for coordination.
 1. County may engage a testing agency to perform additional testing at County's cost before installation of floor covering. Coordinate and schedule testing work with County's testing agency. Number of tests shall be determined by the testing agency. Provide testing surfaces as required by County's testing agency.
 2. Conduct tests at the same temperature and humidity expected during normal facility use. If this is not possible, the test conditions shall be 75 degrees F \pm 10 degrees F and 50 percent \pm 10 percent relative humidity. Maintain these conditions 48 hours prior to and during tests.
- B. Pre-Installation Testing: Perform pre-installation testing of concrete slab by pH, calcium chloride, and relative humidity tests prior to surface preparation for application of the System. Testing shall be performed by qualified testing personnel and testing agency. Test shall determine the change in weight of moisture-absorbing anhydrous calcium chloride and represent the amount of moisture transmitting out of the concrete slab area. The value shall be expressed in "pounds" and calculated as equivalent weight of the water that is emitted from a 1,000 sq. ft. concrete slab surface area in a 24 hour period of time.
 1. Concrete Testing: Perform testing for concrete deficiencies and contaminants, and to confirm that no curing compounds, sealers, coatings, un-reacted silicates, chlorides, and A.S.R. (alkali-silica reaction) are present.

2. pH Testing: Perform three pH tests for the first 1,000 sq. ft. and one test for each 1,000 sq. ft. thereafter.
 3. Vapor Emission Testing: Perform three calcium chloride tests for the first 1,000 sq. ft. and one test for each 1,000 sq. ft. thereafter.
 4. Relative Humidity Testing: Perform tests for relative humidity in the concrete slab per ASTM F2170. Perform three tests for the first 1,000 sq. ft. and one test for each 1,000 sq. ft. thereafter.
- C. Post-Installation Testing: After the System application is complete and before installing floor covering, test floors for moisture by using a Calcium Chloride test kit. Test in accordance with the System manufacturer's specifications and ASTM F1869. Results shall be submitted to Project Manager for evaluation. When test results are above the allowable moisture emission specified for the intended floor covering materials, resolve the condition prior to installation of floor covering. Environment of all tests shall be the same during testing.
1. Environmental requirements for the area to be tested shall be as required for the finished floor covering (i.e. doors, windows, roofing, etc., shall be installed and the temperature of the building controlled to a finished building atmosphere).
 2. Do not execute tests when building interior is below 65 degrees F for 72 hours prior to and throughout the duration of the tests.
 3. Vapor Emission Testing: Perform three calcium chloride tests for the first 1,000 sq. ft. and one test for each 1,000 sq. ft. thereafter.
 4. Adhesion Test: Perform adhesion compatibility test for flooring adhesives, coatings, and leveling compounds over completed vapor emission control system, as acceptable to Project Manager and County.
- D. Document and submit all pH, calcium chloride, relative humidity, and adhesion test results to Project Manager.

3.3 PREPARATION

- A. Prior to installation of compliance system all walls and previously installed floor coverings shall be masked or otherwise protected from the effects of scarification and system application.
- B. Clean and prepare substrates according to the System manufacturer's written recommendations to produce clean, dust-free, dry substrate for the System application.
- C. Remove silicate based floor hardeners or curing compounds from concrete slabs as recommended by the System manufacturer.
- D. Remove defective materials, and foreign matter, such as, dust, adhesives, paint, dirt, floor hardeners, bond breakers, oil, grease, curing agents, form release agents, efflorescence, and laitance.
- E. Cracks, control joints, and cold joints shall be prepared and treated in accordance with the System manufacturer's requirements.
- F. Clean and fill chips, voids and other surface irregularities with repair materials as recommended by the System manufacturer.
- G. Acid etching is not permitted.
- H. Shot blast concrete surface to profile recommended by System manufacturer to ensure bonding of the System to concrete.

- I. Concrete slabs to receive resilient flooring shall conform to applicable requirements of ASTM F710.
- J. Before application of the System, prepared surfaces shall be inspected by and acceptable to the System manufacturer's technical representative.

3.4 INSTALLATION

- A. General: Install vapor emission control system in accordance with manufacturer's written instructions.
- B. Application Temperature Limits: Install the System within the following temperature limitations:
 - 1. Above 50 degrees F and below 90 degrees F; with relative humidity less than 80 percent.
- C. Installation Requirements and Procedures:
 - 1. Application: Unless otherwise required by the System manufacturer, apply one coat of vapor emission control system at an average coverage rate of 70-130 sq. ft./gallon using a squeegee and or 3/8 inch nap roller leaving no areas untreated. Allow the System to cure for a minimum of 12 hours before installing floor covering.
 - a. Coverage rates shall be in accordance with the System manufacturer's recommendations and based on concrete density and porosity.
 - 2. Environmental Conditions: Install the System in environmental conditions that are representative of the environmental operating conditions of finished project.
- D. When a leveling underlayment is required over completed vapor emission control system, and if water based adhesives are used for installation of floor covering, apply appropriate primer to the cured vapor emission control system, as recommended by the System manufacturer. Underlayment shall have adequate thickness to absorb any residual water from the adhesive, unless otherwise recommended by the System manufacturer.

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Services: Conduct pre-installation testing and the System installation in the presence of manufacturer's representative.

3.6 CLEANING

- A. Remove all debris resulting from the System installation from Project site.

3.7 PROTECTION

- A. Protect installed vapor emission control system during curing period from traffic, topical water, and surface contaminants.

END OF SECTION

PART 1 GENERAL

1.1 SUMMARY

- A. This Section Includes:
1. Preformed standing seam metal roofing panels.
 2. Flashings, trim, closures, fasteners, and other accessory items for a complete watertight installation.
- B. References:
1. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
 2. American Society of Testing Materials (ASTM):
 - a. ASTM A653/A653M - 19a Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - b. ASTM A792/A792M Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.
 - c. ASTM A924/A924M Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot Dip Process.
 - d. ASTM C203 Standard Test Method for Breaking Load and Flexural Properties of Block Type Thermal Insulation.
 - e. ASTM C1177/C1177M Standard Specification for Glass Mat Gypsum substrate for Use as Sheathing.
 - f. ASTM C1289 Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board.
 - g. ASTM C1371 Standard Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emisometers.
 - h. ASTM C1549 Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer.
 - i. ASTM D226 Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.
 - j. ASTM D659 Standard Guide for Testing Industrial Water-Reducible Coatings.
 - k. ASTM D822 Standard Practice for Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings.
 - l. ASTM D1056 Standard Specification for Flexible Cellular Materials – Sponge or Expanded Rubber.
 - m. ASTM D1621 Standard Test Method for Compressive Properties of Rigid Cellular Plastics.
 - n. ASTM D1622 Standard Test Method for Apparent Density of Rigid Cellular Plastics.
 - o. ASTM D2126 Standard Test Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging.
 - p. ASTM D2244 Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates.
 - q. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials.
 - r. ASTM E96 Standard Test Methods for Water Vapor Transmission of Materials.
 - s. ASTM E1918 Standard Test Method for Measuring Solar Reflectance of Horizontal and Low-Sloped Surfaces in the Field.
 - t. CAN/ULC S770 Test Method for Determination of Long-Term Thermal Resistance of Closed-Cell Thermal Insulating Foams.

1.2 SUBMITTALS

- A. Product Data: manufacturer's descriptive literature and product specification for each product.
- B. Shop Drawings: Indicate layout including dimensions, sizes, and components. Show details of anchoring, closure, clips, trims, and accessories. Show interface with adjacent surfaces.
- C. Samples: Two (2) samples of each material and finish specified.

1.3 PERFORMANCE REQUIREMENTS

- A. Movement: Accommodate movement within roof panel system including perimeter components without damage to components or deterioration of seals when subjected to seasonal temperature cycles, dynamic loading and release of loads, and deflection of structural support framing.
- B. Drainage: Provide positive drainage to exterior for moisture entering or condensation occurring within panel systems.
- C. Thermal: Provide continuity of thermal barrier at building closure elements in conjunction with thermal insulating materials.

1.4 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Manufacturer Qualifications: Firm specializing in manufacturing products specified in this Section with a minimum 10 years' experience.
 - 2. Installer Qualifications: Firm specializing in installing work specified in this Section directly employed by manufacturer or acceptable to manufacturer with experience on at least 5 projects of similar nature in past 3 years.
- B. Requirements of Regulatory Agencies:
 - 1. Metal roofing systems shall be Class A per CBC Section 1505.
 - 2. Metal roofing systems shall meet or exceed the wind uplift requirements for the location of the installation as per CBC.
- C. Pre-Installation Meetings
 - 1. Conduct pre-installation meeting.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Provide adequate protection so material is not exposed to weather or moisture prior to erection.
- B. Units of panels that become deformed or damaged from any cause whatsoever, to the extent that they are weakened or unsuitable for use as part of the finish surface, shall be replaced unless they can be repaired to the satisfaction of Architect.
- C. Protect panels from accelerated weathering by removing or venting sheet plastic shipping wrap.
- D. Store pre-finished material off the ground, protected from weather to prevent twisting, bending or abrasion, and to provide ventilation. Slope metal sheets to ensure drainage.

- E. Prevent contact with materials capable of causing discoloration or staining.

1.6 WARRANTIES

- A. Immediately upon acceptance of roofing work at the time of Final Project Completion, Contractor, metal panel installer and metal panel manufacturer shall execute and deliver to Project Manager, the following Guarantees/Warranties:
 - 1. Twenty (20) year unlimited Penal Sum Warranty for material failure and finish failure (cracking, checking, blistering, peeling, flaking, chipping, chalking, and fading) by metal panel manufacturer for all panel systems specified in this Section.
 - a. Finish coating shall not peel, blister, chip, crack or check in finish, and shall not chalk in excess of 8 numerical ratings when measured in accordance with ASTM D659.
 - b. Finish coating shall not change color or fade in excess of 5 NBS units as determined by ASTM D822 and ASTM D2244.
 - 2. Five (5) year water tightness Guarantee/Warranty by Contractor and Metal Panel Installer warranting panels, flashings, sealants, fasteners and accessories against defective materials and workmanship, to remain watertight and weatherproof:
 - a. Emergency repairs will be made within 24 hours' notice by County of leakage or defect. As soon as weather permits, affected areas will be permanently restored to standards of quality, i.e. workmanship, durability and appearance called for in the Contract Documents. Emergency repairs will be made without any charge to the County. The value of this Agreement shall not be limited to a specific maximum sum. County maintenance will not be required as a condition to continuation of this Agreement.
 - b. Excluded from this Agreement are leaks or defects caused by abuse, vandalism, extraordinary roof deck movement, fire or other casualty. This agreement binds the undersigned and any of their agents, successors, legal representatives or assigns during the life of the Agreement.
 - 3. Twenty (20) year water tightness Guarantee/Warranty by metal panel manufacturer for all panel systems specified in this Section.
 - a. Emergency repairs will be made within 24 hours' notice by County of leakage or defect. As soon as weather permits, affected areas will be permanently restored to standards of quality, i.e. workmanship, durability and appearance called for in the Contract Documents. Emergency repairs will be made without any charge to the County. The value of this Agreement shall not be limited to a specific maximum sum.
- B. Warranty includes removal, replacement, repair, and making good without cost to the County, of defects due to defective materials or workmanship.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers and Products:
 - 1. Basis of Design: Metal Sales Manufacturing Corp., Curved Magna Lock 180 & Curved 1" Mini-Batten
 - 2. MBCI
 - 3. AEP Span
 - 4. Or approved equal.

2.2 METAL ROOF PANELS

- A. Metal Standing Seam Roofing System: Arching pre-finished, 16 inch net coverage; striated

pan; 2 inch tall, 90 degree field seams; concealed anchors that resist wind uplift yet permits expansion and contraction with temperature changes.

- B. Base Metal: 20 gauge zincalume sheet, ASTM AZ50 made of 55% aluminum, 1.6% silicone and the balance of zinc, conforming to ASTM A792

2.3 ACCESSORIES AND RELATED MATERIALS

- A. Fasteners, Clips, Cleats, Thermal Spacer, Flat Bearing Plate: Corrosion-resistant type as provided by manufacturer to complete a concealed anchorage system and to ensure a water and weatherproof installation. Fasten clips over flat bearing plates over rigid insulation.
- B. Closures: Metal or black closed cell pre-molded neoprene or polyethylene foam meeting ASTM D1056 grade SCE-41 Black EPT.
- C. Flashings and Trim: Same gauge, material and finish as metal roof. Profiles as shown on Drawings.
- D. Rigid Insulation: 6 inch uniform thickness closed-cell polyisocyanurate foam core integrally laminated to heavy black (non-asphaltic), fiber-reinforced felt facers with square edges; conforming to ASTM C1289, Type II, Class 1; Grade 2 (20 psi minimum compressive strength); surface burning characteristics: flame spread 25 to 50 and smoke developed 50 to 170 per ASTM E84; long-term thermal resistance (LTTR) value minimum 5.5 F-hr-SqFt / Btu / inch at 75 degrees F per CAN/ULC-S770. Product: ACFoam-II by Atlas Roofing Corp., Multi-Max FA by Rmax, Inc. ISO 95+ by Firestone Building Products Co, or accepted equal.
- E. Gypsum Cover Board: Glass mat-faced, noncombustible, moisture-resistant treated gypsum core panel; 1/4 inch thick, square edges; conforming to ASTM C1177. Product: DensDeck as manufactured by Georgia Pacific Corp. (phone: 404.652.4000; URL: <http://www.gp.com>), or accepted equal.
- F. Sheet Waterproofing Membrane.

2.4 FABRICATION

- A. Form sections to configuration indicated on drawings, accurate in size, square and free from distortion or defects.
- B. Fabricate panel pieces in longest practicable lengths
- C. Fabricate flashings, gutters and accessories in longest practical lengths.

2.5 FINISH

- A. Factory Finish: DuraTech mx pearlescent paint system consisting of a 0.2 mil thick corrosion-resistant primer and 0.8 mil thick finish coat of Polyvinylidene Fluoride (PVDF), full 70% Kynar 500/Hylar 5000 for total coating thickness of 1.0 mil dry film thickness.
- B. Color: To be selected from manufacturer's full range of colors.
 - 1. Solar Reflectivity: 0.35 per ASTM C1549.
 - 2. Thermal Emissivity: 0.84 per ASTM C1371.
 - 3. Solar Reflective Index: 36 per ASTM E1918.

2.6 SEALANTS

- A. As recommended by the manufacturer and complying with the requirements of TT-S-00230.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify supporting substrate surfaces are ready to receive panel system. Surfaces in contact with panels shall be free from debris or objects that may damage panels.
- B. Report unacceptable conditions to the County. Begin installation only when unacceptable conditions have been corrected.

3.2 INSTALLATION

- A. Workmanship: All work shall be neat, trim, true to line and, upon completion, shall present a true finished surface of the specified profile, free of dents, deformations, creases or other noticeable defects.
- B. Protection:
 - 1. Treat, or isolate with protective material, any contacting surfaces of dissimilar materials to prevent electrolytic corrosion.
 - 2. Require workmen working on roofing panels to wear clean, soft-soled shoes that will not pick up stones or other abrasive material which could damage or discolor panel surface.
 - 3. Protect work of other trades from damage.
- C. Insulation Installation:
 - 1. Lay multiple layers of roof insulation to achieve specified thickness in accordance with manufacturer's instructions. Stagger joints of layers.
 - 2. Lay boards with edges in moderate contact without forcing. Cut insulation to fit neatly to perimeter blocking and around penetrations through roof.
 - 3. Apply no more insulation than can be covered with roof panels in same day.
 - 4. Tape joints of insulation in accordance with insulation manufacturer's instructions.
- D. Gypsum Cover Board Installation:
 - 1. Place cover board over clean insulation.
 - 2. Fasten with disk-type fasteners as recommended by cover board manufacturer.
 - 3. Stagger all joints a minimum of 6 inches from underlying insulation joints.
- E. Sheet Waterproofing Membrane Installation:
 - 1. Install per manufacturer's recommendations.
- F. Roofing Installation:
 - 1. Install roofing, anchorage, and all accessories strictly in accordance with manufacturer's instructions and approved shop drawings.
 - 2. Remove any strippable protective coating on the panels and flashings prior to installation and in any case do not allow the strippable coating to remain on the panels in extreme heat, cold or in direct sunlight or other UV source.
 - 3. Lap panels away from prevailing wind direction.
 - 4. Attach panels to substrate with clips and fasteners. Secure panels without warp or deflection. Install to allow for thermal movement.
 - 5. Install flashings to allow for thermal movement.
 - 6. Attach flashings and trim pieces with mechanical fasteners and sealant.
 - 7. Install all battens and closures as indicated or required for a watertight installation.
 - 8. Perforations/punctures of roof panels are not permitted, except as required for anchoring and installation of trims and flashings.

9. Provide 90 degree interlocking seams

3.3 ERECTION TOLERANCES

- A. Maximum alignment variation: 1/4 inch in 40 feet.
- B. Maximum variation from plane or location indicated on the drawings: 1/4 inch.

3.4 ADJUST AND CLEAN

- A. Cleaning and Finishing: Upon completion of the work clean all exposed surfaces with mild soap and water, removing any discoloration or foreign matter. Touch up all abraded or cut areas and exposed edges with finishing material recommended by the manufacturer. Touch-up shall not be noticeable when viewed from 10 feet.
- B. Defective Work: Remove and replace any defective work which cannot be properly repaired, cleaned or touched up, as directed by Project Manager, with no additional cost to County.
- C. Protect all installed work against damage from other construction work.

3.5 CLEAN UP

- A. Upon completion of the work of this section, remove all surplus materials, rubbish and debris from the premises. Contractor shall thoroughly clean entire roof area at completion of project.

END OF SECTION

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Mechanically attached PVC sheet membrane roofing system.
- B. Underlayment Board.
- C. Coated flashings and trim.
- D. Rigid insulation at roof construction.
- E. Tapered cricket system.
- F. Walkway membrane (Traffic Pads).

1.2 REFERENCES

- A. Unless otherwise noted, standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes as of the date of issue of this Project Manual.
- B. Referenced Standards and Manuals:
 - 1. ANSI/SPRI FX-1 Standard Field Test Procedure for Determining the Withdrawal Resistance of Roofing Fasteners
 - 2. ASTM C203 –Standard Test Method for Breaking Load and Flexural Properties of Block Type Thermal Insulation.
 - 3. ASTM C272 –Standard Test Method for Water Absorption of Core Materials for Structural Sandwich Constructions.
 - 4. ASTM C518 –Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
 - 5. ASTM C1177/C1177M–Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing.
 - 6. ASTM C1289 –Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board.
 - 7. ASTM D471 –Standard Test Method for Rubber Property – Effects of Liquids.
 - 8. ASTM D751 – Standard Test Methods for Coated Fabrics.
 - 9. ASTM D1204 – Standard Test Method for Linear Dimensional Changes of Non-Rigid Thermoplastic Sheathing or Film at Elevated Temperature.
 - 10. ASTM D1621 – Standard Test Method for Compressive Properties of Rigid Cellular Plastics.
 - 11. ASTM D1622 – Standard Test Method for Apparent Density of Rigid Cellular Plastics.
 - 12. ASTM D2126 – Standard Test Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging.
 - 13. ASTM D5884 – Standard Test Method for Determining Tearing Strength of Internally Reinforced Geomembranes.
 - 14. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials.
 - 15. ASTM E96 Standard Test Method for Water Vapor Transmission of Materials.
 - 16. ASTM E408 Standard Test Method for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques.
 - 17. Factory Mutual Global (FMG) Approval Guide.
 - 18. UL Roofing Materials and Systems Directory.

1.3 QUALITY ASSURANCE

- A. Membrane Manufacturer: Prime membrane manufacturer, specializing in single ply roof membranes with five years experience.
- B. Applicator: Company specializing in installation of single ply roof membranes approved by membrane manufacturer.

1.4 REGULATORY REQUIREMENTS

- A. Underwriters Laboratories, Inc (UL) Class A Fire Hazard Classification.

1.5 SUBMITTALS

- A. Shop drawings detailing special joint or termination conditions and conditions of interface with other materials.
- B. Product data for sheet membrane, elastic flashing, joint cover sheet, and joint and crack sealants, with temperature range for application of membrane.
- C. Manufacturer's installation instructions.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products in manufacturer's original containers, dry and undamaged, with seals and labels intact.
- B. Store products in weather protected environment, clear of ground and moisture.
- C. Store insulation and cover board dry and protected from the elements. Store insulation on pallets and completely cover with a breathable material such as tarp or canvas. Remove or slit temporary factory-applied packaging to prevent accumulation of condensation. Do not use wet or damaged insulation.
- D. Store roofing membrane in the original undisturbed plastic wrap.
- E. Store adhesives, sealants, and other curable materials in cool and dry location with temperatures between 60 and 90 degrees F. Do not store adhesive containers with opened lids due to the loss of solvent which occur from flash off.

1.7 ENVIRONMENTAL REQUIREMENTS

- A. Do not apply roofing system during inclement weather.
- B. Do not apply roofing system to damp or frozen substrate.
- C. Take precautions to prevent wind blow-off or wind damage during the course of the roofing application.
- D. Substrates to receive roofing system shall be thoroughly dry. Provide drying equipment should moisture occur.

1.8 PREINSTALLATION CONFERENCE

- A. Convene a pre-installation conference one week prior to commencing work of this Section.

- B. Require attendance of parties directly affecting work of this Section.
- C. Review conditions of installation, installation procedures, and coordination required with related work.

1.9 MOCKUP

- A. Provide mockup of installed membrane prior to commencement of work.
- B. Mockup to represent conditions of finished work including internal and external corners, Seam jointing, attachment method, sealing and counterflashing cover, control and expansion joints.

1.10 EXTRA STOCK

- A. Provide the Owner with 72 sq. ft. of roofing membrane along with the compatible hand held hot-air welding tool and written instructions for the repair of minor defects and punctures to the membrane; for his use.

1.11 WARRANTY

- A. Warranty installed membrane roofing system including labor and materials and loss of water-tightness caused by defective materials (including accessories) or workmanship, with no dollar limit, for 20 years. Effective warranty start date shall be at the time of final acceptance by County.
- B. Warranty shall provide for the removal, replacement, repair, and making good without cost to the County, of defects due to defective materials or workmanship.
- C. Repairs under warranty shall be made within three days after receiving notice of need for repairs from the County, weather permitting.

PART 2 PRODUCTS

2.1 MANUFACTURERS AND PRODUCTS

- A. Acceptable Manufacturers and Products.
 - 1. PVC Roofing Membrane System.
 - a. Carlisle Syntec Inc.
 - b. Firestone Building Products Co.
 - c. GAF Materials Corp.
 - d. John Mansville
 - e. Or accepted equal.
 - 2. Gypsum Underlayment board.
 - a. G-P Gypsum Corp.: DensDeck roof board.
 - b. Or accepted equal.
 - 3. Roof Insulation.
 - a. Atlas Roofing Corp.
 - b. Rmax, Inc.
 - c. Firestone Building Products Co.
 - d. GAF Materials Corp.
 - e. John Mansville
 - f. Or accepted equal.

2.2 POLYVINYL-CHLORIDE ROOFING MEMBRANE - PVC

- A. PVC Sheet: ASTM D 4434, Type III, fabric reinforced. Thickness: 60 mils, minimum.

2.3 AUXILIARY ROOFING MATERIALS – SINGLE PLY

- A. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with membrane roofing.
 - 1. Liquid-type auxiliary materials shall meet VOC limits of authorities having jurisdiction.
 - a. Sheet Flashing: Manufacturer's sheet flashing of same material, type, reinforcement, thickness, and color as sheet membrane.
 - b. Sheet Flashing: Manufacturer's unreinforced sheet flashing of same material as sheet membrane.
 - c. Slip Sheet: Manufacturer's recommended slip sheet, of type required for application.
 - d. Metal Termination Bars: Manufacturer's standard predrilled stainless-steel or aluminum bars, with anchors.
 - e. Metal Battens: Manufacturer's standard aluminum-zinc-alloy-coated or zinc-coated steel sheet, prepunched.
 - f. Fasteners: Factory-coated steel fasteners and metal or plastic plates meeting corrosion-resistance provisions in FMG 4470, designed for fastening membrane to substrate, and acceptable to membrane roofing system manufacturer.
 - g. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, termination reglets, cover strips, sealants, and other accessories.

2.4 WALKWAYS

- A. Flexible Walkways: Factory-formed, nonporous, heavy-duty, slip-resisting, surface-textured walkway pads sourced from membrane roofing system manufacturer.

2.5 UNDERLAYMENT BOARD

- A. Gypsum Board: ASTM C1177, glass-mat faced, water-resistant gypsum substrate, 1/4 inch at.

2.6 ROOF INSULATION

- A. General: Provide preformed roof insulation boards that comply with requirements and referenced standards, selected from manufacturer's standard sizes and of thicknesses indicated.
- B. Polyisocyanurate Board Insulation: ASTM C 1289, Type II.
 - 1. Provide insulation package with R Value greater than 30.

2.7 TAPERED INSULATION

- A. Tapered Insulation: ASTM C 1289, provide factory-tapered insulation boards fabricated to slope of 1/2 inch per 12 inches unless otherwise indicated.

2.8 INSULATION ACCESSORIES

- A. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatible with membrane roofing.

- B. Provide factory preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.
- C. Fasteners: Factory-coated steel fasteners and metal or plastic plates meeting corrosion-resistance provisions in FMG 4470, designed for fastening roof insulation to substrate, and furnished by roofing system manufacturer.
- D. Urethane Adhesive: Manufacturer's two component urethane adhesive formulated to adhere insulation to substrate.
- E. Wood Nailer Strips.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Report unacceptable conditions to the Engineer. Begin installation only when unacceptable conditions have been corrected and only when substrate is inspected and accepted by roofing installer and roofing system manufacturer.
- B. Verify that surfaces and site conditions are ready to receive work.
- C. Verify that deck is structurally sound to secure mechanical fastened single ply roofing system. Inspect roof deck for corrosion, rotting, warping, concrete spalling, etc. Repair or replace defective roof deck prior to installing the roofing system.
- D. Verify that deck surfaces are dry to the touch and free of snow or ice.
- E. Verify that deck is clean and smooth, free of noticeable high spots or depressions, and have a positive slope to drains or valleys.
- F. Perform pullout tests as per ANSI/SPRI FX-1 at a minimum of 10 pullout tests for areas up to 500 squares, thereafter, add one test for every 2 percent of the field areas.
- G. Verify that roof openings, curbs, pipes, sleeves, ducts and vents through roof are solidly set. Verify and ensure that all roof drain lines are clear.

3.2 PREPARATION

- A. Protection: Protect roofing surface and adjacent work against damage to roofing work.
- B. Review Material Safety Data Sheet and safety regulations recommended by OSHA.
- C. Wood Nailers:
 - 1. Install pressure treated wood nailers in appropriate size and location when required by the membrane manufacturer for a warrantable system.
 - 2. Anchor to the roof deck at 2 feet maximum on center to resist a pullout force of 175 pounds per foot in any direction. Install fasteners within 6 inch of each end. Spacing and fastener embedment shall conform to Factory Mutual Loss Prevention Data Sheet 1-49.
 - 3. Top of nailers shall be flush to the roof insulation.

3.3 PREPARATION OF SUBSTRATE

- A. General: To prevent delays or interruptions, coordinate with other work to ensure that components to be incorporated into the roofing system are available as the work progresses.

Examine substrates to which the roofing materials are to be applied to ensure that their condition is satisfactory for the roofing systems application. Do not permit voids greater than 1/4 inch width in the substrate. Substrates for roofing materials shall be dry and free of oil, dirt, grease, sharp edges and debris. Inspect substrates and correct defects before application of roofing membrane.

- B. Determine the condition of the structural substrate. Areas with deteriorated or damaged decking or other materials shall have those affected materials removed and replaced.
- C. Provide temporary water cut-offs at the end of each day. Maintain watertight condition of roof. Remove only that amount of roofing and flashing that can be made watertight with new materials in a one-day period or prior to the onset of inclement weather.
- D. Cover decking with rigid insulation, and cover board, applied in accordance with manufacturer's instructions and as required resulting in a UL Class A roof system.

3.4 INSULATION INSTALLATION

- A. Place insulation over clean roof deck where indicated on drawings in accordance with manufacturer's instructions.
- B. Install insulation in specified thickness. Install additional thickness at crickets as required to meet requirements indicated on the drawings.
- C. Lay boards with edges in moderate contact without forcing. Cut insulation to fit neatly to perimeter blocking and around penetrations through roof.
- D. Apply no more insulation than can be covered with cover board and membrane in same day.
- E. Tape joints of insulation in accordance with insulation manufacturer's instructions.
- F. Stagger all joints when multiple layers or types of insulation are being installed.

3.5 GYPSUM UNDERLAYMENT BOARD INSTALLATION

- A. Place cover board over clean insulation or plywood roof substrate.
- B. Fasten with disk-type fasteners as recommended by cover board manufacturer.
- C. Stagger all joints a minimum of 6 inches from underlying insulation joints.

3.6 ROOFING MEMBRANE PLACEMENT, ATTACHMENT AND HOT AIR WELDING

- A. General: Install membrane in accordance with manufacturer's instructions.
- B. Sweep substrate of all loose debris before laying membrane.
- C. Mechanically-Fastened Single-Ply Roofing System
 1. Roll out membrane free from wrinkles or tears. Place sheet into place without stretching. Allow the membrane to relax at least 15 minutes when the temperature is above 60 degrees F or 40 minutes when the temperature is below 60 degrees F prior to installation. Inspect for damage. Remove sections of membrane that are creased or damaged. Lap sheets as recommended by manufacturer.
 2. Perimeter: When installing roofing, where walls do not exceed or equal 24 inches in height, install a minimum of one sheet parallel with the perimeter and fasten with

fastening system at the predetermined spacing in the lap area in a line centered approximately 1-1/2 inch from the edge of the sheet leaving 1/2 inch of membrane outside the disc. Weld lap area to metal base flashing continuously a minimum of 1-1/2 inches weld width.

3. Field Areas: Run membrane perpendicular to roof slope. Install membrane overlaps to facilitate the flow of water. Overlap membrane sheets as recommended by manufacturer to provide space for fastener and disc placement for a continuous 1-1/2 inch width weld.
 4. Seal membrane continuous around all roof penetrations.
- D. Fully-Adhered Single-Ply Roofing System at Vertical Surfaces.
1. Position membrane over the substrate.
 2. Fold membrane sheet back so half the underside is exposed.
 3. Stir bonding adhesive thoroughly scraping the sides and the bottom of the can (5 minutes minimum). Bonding surfaces must be dry and clean.
 4. Apply bonding adhesive to the exposed underside of the membrane and the corresponding substrate area. Do not apply adhesive along the splice edge of the membrane to be hot air welded over adjoining sheet.
 5. Apply adhesive evenly, without puddles using a plastic core medium nap roller to achieve continuous coating of both surfaces at a coverage rate recommended by adhesive manufacturer.
 6. Due to solvent flash-off, condensation may form on freshly applied bonding adhesive when the ambient temperature is near the dew point. If condensation develops, possible surface contamination may occur and the application of bonding adhesive must be discontinued. Allow the surface to dry and apply a thin freshener coat to the previously coated surface when conditions allow for continuing.
 7. Allow adhesive to dry until it is tacky but will not string or stick to a dry finger touch.
 8. Roll the coated membrane into the coated substrate while avoiding wrinkles.
 9. Brush down the bonded section of the membrane sheet immediately after rolling the membrane into the adhesive with a soft bristle push broom to achieve maximum contact.
 10. Fold back the unbonded half of the sheet in the same manner, overlapping edges a minimum of 2 inch to provide for a minimum of 1-1/2 inch hot air weld.
 11. Install adjoining membrane sheets in the same manner, overlapping a minimum of 2 inch to provide a minimum of 1-1/2 inch hot air weld.
 12. Protect completed sections of the roof so bonding adhesive will not discolor the membrane surface. Do not place bonding adhesive containers or their lids directly on the surface of the membrane.
- E. Welding of Laps:
1. General:
 - a. Roofing membrane connection shall be hot air welded only.
 - b. Surfaces to be welded shall be clean and dry.
 2. Hot Air Welding:
 - a. Hot air weld the membrane sheets with an automatic hot air welding machine. Follow hot air welding machine manufacturer's instructions for use.
 - b. Where use of automatic hot air welding machines is not practical, use a hand-held hot air welding machine. Preheat the nozzle tip and apply over the overlap area until the material reaches required temperature, immediately follow with a hand roller to press the heated membrane surfaces together with slow, even movements. Keep the roller within one inch of the nozzle tip. Seam strength may be tested when cool. For best results, test seams 8 hours after hot air welding.
 3. Quality Control of Seams: After seaming, check welded seams for continuity and integrity. Repair openings or "fishmouths" with a hand-held hot air tool fitted with a narrow nozzle tip and with a roller.
 4. Membrane lap edges that have been exposed to the elements for approximately 7 days or longer must be prepared with manufacturer-approved membrane cleaner. Prepare the surface where the cleaner has been applied as per manufacturer's instructions prior to

hot air welding.

3.7 MEMBRANE FLASHING

- A. Flash all vertical surfaces with reinforced membrane. Use non-reinforced membrane only at inside and outside corners, field fabricated pipe seals, scuppers, and sealant pockets where the use of premolded accessories are not practical. Terminate the flashing in accordance with manufacturer-approved detail.
- B. Use bonding adhesive on vertical surfaces more than 12 inches high such as walls, curbs, and pipes. Bonding adhesive is not required for vertical surfaces terminated under a metal counter flashing less than 12 inches high. Bonding adhesive may be eliminated for flashing heights 18 inches or less when a coping or termination bar is used for vertical terminations.

3.8 OTHER RELATED WORK

- A. Walkways: Heat weld walkway pads as directed by the manufacturer and as shown on the drawings.
- B. At the underside of exposed decking, cover fastener tips of protruding fasteners with heat-shrink wrap tubing. Paint to match existing color or new paint where occurs

3.9 FIELD QUALITY CONTROL

- A. General: Comply with requirements of Section 01 40 00 "Quality Requirements".
- B. The manufacturer's representative/technical inspector shall observe, conduct tests, and prepare test reports in accordance with the provisions of this Section at predetermined periods before, during, and after installation of the work – specifically at critical periods identified by roofing system manufacturer to ensure a completely warranted system.
- C. The manufacturer's representative/technical inspector and the testing agency shall conduct final roof inspection on completion of the work in this Section and submit report to Engineer. Notify Engineer 48 hours in advance of date and time of inspection.

3.10 CLEANING

- A. Clean as recommended by manufacturer. Do not use materials or methods which may damage surface or surrounding construction.
- B. Where traffic must continue over finished roof membrane, protect surfaces.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Exterior wall flashings.
- B. Roof flashings.
- C. Pre-manufactured copings.
- D. Pre-manufactured roof penetration flashings.
- E. Reglets.

1.2 REFERENCES

- A. Unless otherwise noted, standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes as of the date of issue of this Project Manual.
- B. Referenced Standards:
 - 1. AAMA 2605 Voluntary Specifications, Performance Requirements, and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.
 - 2. ASTM A653/A653M Standard Specification for Steel Sheet, Zinc Coated, (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - 3. ASTM A924/A924M Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
 - 4. ASTM B32 Standard Specification for Solder Metal.
 - 5. ASTM B209/B209M Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).
 - 6. ASTM G90 Standard Practice for Performing Accelerated Outdoor Weathering of Nonmetallic Materials Using Concentrated Natural Sunlight
 - 7. FS SS-C-153 Type I-asphaltic base cement
 - 8. FS TT-C-494 Coating Compound, Bituminous, Solvent Type, Acid Resistant.
 - 9. NRCA Roofing Manual.
 - 10. SMACNA Architectural Sheet Metal Manual.

1.3 SUBMITTALS

- A. Shop drawings and Product Data: Describe material profile, jointing pattern, jointing details, fastening methods and installation details.

1.4 QUALITY ASSURANCE

- A. Applicator: Company specializing in sheet metal flashing work with sufficient documented experience.

1.5 SYSTEM DESCRIPTION

- A. Work of this Section is to physically protect roofing and exterior from damage that would permit water leakage to building interior.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Stack preformed material to prevent twisting, bending or abrasion, and to provide ventilation.
- B. Prevent contact with materials during storage that may cause discoloration, staining or damage.

PART 2 PRODUCTS

2.1 PREMANUFACTURED COPINGS

- A. Manufacturers:
 - 1. W.P. Hickman Systems, Inc.
 - 2. Tremco.
 - 3. Metal Era.
 - 4. Permatite.
 - 5. Pac-Clad
 - 6. Or accepted equal.
- B. Copings: Modular Coping System.
 - 1. Coping shall be 0.063 thick aluminum with smooth surface.
 - 2. Sizes as required to accommodate varying wall thicknesses.
 - 3. Splice joints shall have 6" long concealed splice plates at 10'-0" on center. Allow 1/4" at all butt joints per 10'-0" length.
 - 4. Prefabricated corners shall be shop mitered and shop welded.
 - 5. All fasteners shall be concealed.
 - 6. Finish: Pre-finished Kynar, color as selected by Architect.

2.2 PREMANUFACTURED ROOF PENETRATION FLASHINGS

- A. At new thermoplastic membrane roofing:
 - 1. Pipe Portal System as manufactured by Portals Plus or accepted equal. System shall consist of the following:
 - a. Roof Curb: Straight sides, 18 gauge, ASTM A653 G90 galvanized iron with mitered and welded corners, softwood lumber wood nailers on all four sides, EPDM gaskets, and insulated on all four sides with 1-1/2 inch thick, 3# density rigid fiberglass insulation.
 - b. Curb Cover: One piece molded ABS plastic laminated with an ultraviolet-resistant acrylic coating. Cover shall be molded with reinforcing ribs on the top surface, crowned to shed water, and have integral counterflashing with drip edge and pre-punched perimeter holes for field attachment to perimeter nailer of curb. Provide a molded sealing ring around the perimeter of the molded collared penetration openings.
 - c. Pipe Boots: Compression molded EPDM rubber caps mechanically sealed to curb cover using two beads formed into the collar of the cover mated with double grooves molded into the inside of the cap. Provide manufacturer's standard adapter rings as required for a watertight installation. Size and type: As required for size and number of pipes to be flashed.
 - d. Stainless steel clamps for final securement of pipe boots around penetrations.

2.3 REGLETS

- A. Reglets: W.P. Hickman Fry; MM Systems; Superior; or accepted equal, Products:
 - 1. Masonry Flashing System: In-Wall Drive Lock Reglet and Counter Flashing. Material shall be 0.025 inch thick aluminum with gray polyester coating.

2. Flashing Clip: Windlok Clip. Pre-drilled, non- continuous 1 ¼" x 2 ½" metal strap.

2.4 ACCESSORIES

- A. Fasteners: Stainless steel with soft neoprene washers. Finish exposed fasteners same as flashing metal.
- B. Protective Backing Paint: FS TT-C-494A. Bituminous.
- C. Sealant.
- D. Bedding Compound: Rubber-asphalt type.
- E. Plastic Cement: FS SS-C-153, Type I-asphaltic base cement.
- F. Solder: ASTM B32; 95-5 Tin Antimony type.
- G. Flux: As recommended by sheet metal manufacturer.

2.5 FABRICATION

- A. Form sections true to shape, accurate in size, square, and free from distortion or defects.
- B. Fabricate cleats and starter strips of same material as sheet, interlockable with sheet.
- C. Form pieces in longest practical lengths.
- D. Hem exposed edges on underside 1/2"; miter and seam corners.
- E. Form material with flat lock seam.
- F. Solder and seal metal joints watertight. After soldering, remove flux. Wipe and wash solder joints clean.
- G. Fabricate corners from one piece with minimum 18" long legs; seam for rigidity, seal with sealant.
- H. Fabricate vertical faces with bottom edge formed outward 1/4" and hemmed to form drip.
- I. Expansion-contraction of sheet metal runs: Provide flat, loose locking slip joint at maximum of 10 foot intervals.

PART 3 EXECUTION

3.1 INSPECTION

- A. Verify shapes and dimensions of surfaces to be covered.
- B. Verify substrates are clean, dry, smooth and free of defects to the extent needed for sheet metal work.
- C. Beginning of installation means acceptance of existing conditions.

3.2 PREPARATION

- A. Field measure site conditions prior to fabricating work.
- B. Install starter and edge strips, and cleats before starting installation.
- C. Install reglets true to lines and levels. Seal top of reglets with sealant.
- D. Insert flashings into reglets to form tight fit. Secure in place with plastic wedges at maximum 12" on center. Seal flashings into reglets with sealant.
- E. Secure flashings in place using concealed fasteners. Use exposed fasteners only in locations acceptable to Architect.
- F. Lock and seal all joints.
- G. Apply plastic cement compound between metal flashings and felt flashings.
- H. Fit flashings tight in place. Make corners square, surfaces true and straight in planes, and lines accurate to profiles.
- I. Solder metal joints watertight for full metal surface contact. After soldering, wash metal clean with neutralizing solution and rinse with water.
- J. Seal metal joints watertight.

3.3 INSTALLATION

- A. Fabricate and install items in conformance with drawing details and SMACNA and NRCA manuals.
 - 1. Install pre-manufactured items such as copings and roof penetration flashings per manufacturer's recommendations.
- B. Ensure that items are installed in true and accurate alignment with other items and related work; that joints are accurately fitted; that exposed surfaces are free from dents; that corners are reinforced; that seams are watertight.
- C. All work shall be left free of passivators, oil, grease, or acid residue, ready to receive painter's finish.
- D. Wherever possible, all fasteners shall be concealed. All exposed fasteners shall have neoprene gaskets and be capped with a bead of sealant.
- E. Install counter-flashings in reglets with continuous bead of sealant.

3.4 TOUCH-UP

- A. Where galvanized finish is damaged by fabrication or installation, repair with specified touch-up material, applying in accordance with manufacturer's printed instructions.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Work under this Section consists of the furnishing of all labor, materials, equipment and services necessary for, and incidental to, the complete and proper installation of all spray-applied fireproofing and related work as shown on the drawings or specified herein, and in accordance with all applicable requirements of the contract documents.
 - 1. The following schedule is used in the specification:
 - a. Type I – Standard density gypsum based cementitious fireproofing.
- B. The material and installation shall conform to the applicable building code requirements of all authorities having jurisdiction.
- C. For patch and repair work, match adjacent fireproofing thickness to obtain the code-required fire rating for that location.

1.2 REFERENCES

- A. Unless otherwise noted, standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes as of the date of issue of this Project Manual.
- B. Referenced Standards:
 - 1. ASTM D2240 – Standard Test Method for Rubber Property – Durometer Hardness.
 - 2. ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials.
 - 3. ASTM E119 – Standard Test Methods for Fire Tests of Building Construction and Materials.
 - 4. ASTM E605 – Standard Test Methods for Thickness and Density of Sprayed Fire-Resistive Material (SFRM) Applied to Structural Members.
 - 5. ASTM E736 – Standard Test Method for Cohesion/Adhesion of Sprayed Fire-Resistive Materials (SFRM) Applied to Structural Members.
 - 6. ASTM E759 – Standard Test Method for Effect of Deflection on Sprayed Fire-Resistive Material Applied to Structural Members.
 - 7. ASTM E760 – Standard Test Method for Effect of Impact on Bonding of Sprayed Fire Resistive Material Applied to Structural Members.
 - 8. ASTM E761 – Standard Test Method for Compressive Strength of Sprayed Fire-Resistive Material Applied to Structural Members.
 - 9. ASTM E859 – Standard Test Method for Air Erosion of Sprayed Fire-Resistive Materials (SFRMs) Applied to Structural Members.
 - 10. ASTM E937 – Standard Test Method for Corrosion of Steel by Sprayed Fire-Resistive Material (SFRM) Applied to Structural Members.
 - 11. ASTM E1354 – Standard Test Method for Heat Visible Smoke Release Rates for Materials and Products Using an Oxygen Consumption Calorimeter.
 - 12. ASTM G21 – Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
 - 13. UL Fire Resistance Directory.
 - 14. AWCI – "Inspection Procedure for Field-Applied Sprayed Fire Protection Materials"
 - 15. SFM Approved Materials and Equipment Listing Services.

1.3 SUBMITTALS

- A. Manufacturers' Data:
 - 1. Submit manufacturer's instructions for proper application of sprayed fireproofing.
 - 2. Submit product data indicating UL listings, product characteristics and performance and limitation criteria.

- B. Submit manufacturer's certificate stating that products meet or exceed the specified requirements.

- C. Test Data: From a qualified independent testing agency employed and paid by the manufacturer. Provide reports indicating that physical properties of proposed sprayed on fireproofing products comply with specified requirements based on comprehensive testing of current product formulations according to the following requirements:
 - 1. Testing is performed on sprayed on fireproofing materials randomly selected from bags bearing the applicable classification marking of UL or another inspecting and testing agency acceptable to authorities having jurisdiction.
 - 2. Testing is performed on specimens of sprayed on fireproofing materials that comply with laboratory testing requirements specified in Part 2 and are otherwise identical in every respect to the installed fireproofing including application of sealers, topcoats, tamping, troweling, rolling and water overspray, if any of these are used in final application.
 - 3. Qualified independent testing agency does testing on laboratory specimens that it witnessed during preparation and conditioning. Include in test reports a full description of preparation and conditioning of laboratory test specimens.
 - 4. Test reports without the above information are not acceptable.

- D. Fire Testing: Submit evidence that the cementitious fireproofing has been subjected to full scale ASTM E84 and ASTM E119 fire testing by Underwriters Laboratories Inc. Include evidence that the fire testing was sponsored by the manufacturer and that the material tested was produced at the manufacturer's facility under the supervision of Underwriters Laboratories Inc. personnel. Letters documenting classification status are not acceptable evidence of compliance with this section.

- E. Test Reports:
 - 1. For primers and other coatings applied to structural steel from a qualified independent testing agency employed and paid by Contractor indicating that primers and coatings proposed for application in shop or field are compatible with sprayed on fireproofing. Instruct laboratory to determine compatibility as follows:
 - a. By testing for bond per ASTM E 736 and requirements specified in UL "Fire Resistance Directory" about coating materials.
 - b. By verifying that fireproofing manufacturer has not found primers or coatings to be incompatible with fireproofing based on its own laboratory testing or field experience.

- F. Shop Drawings: Submit shop drawings indicating the following:
 - 1. Where and what kinds of surface preparations are required before applying fireproofing.
 - 2. Extent of sprayed fire resistive material for each different construction and fire resistance rating including the following:
 - a. Applicable fire resistive design designations of inspecting and testing agency applicable to authorities having jurisdiction.
 - b. Minimum thickness needed to achieve required fire resistance ratings of structural components and assemblies.
 - c. Treatment of fireproofing after its application.

- G. ICC Evaluation reports or research reports of the model code organization acceptable to authorities having jurisdiction showing that the sprayed fire resistive material complies with

the building code in effect for the Project.

1.4 QUALITY ASSURANCE

- A. Fireproofing work shall be installed by a firm with not less than three years of successful experience in the application of specified fireproofing materials on projects of similar scope. Applicator shall be licensed or otherwise approved in writing by the manufacturer of fireproofing materials.
- B. Products, execution and fireproofing thickness and density shall conform to the applicable code requirements for the required fire-resistance ratings for the type of member / assembly to be fireproofed.
- C. Sprayed fireproofing shall form a sound bond with the steel.
- D. Prior to the execution of work, contractor shall call a pre-installation meeting to review product selection, check substrates for acceptability, verify designs and thickness, discuss inspection procedures, and coordinate the fireproofing installation with the work of other trades. The meeting shall be attended by the contractor, fireproofing applicator, an employee of the fireproofing manufacturer, and a representative of the independent testing agency.
- E. Obtain sprayed fire resistive materials for all required products from a single manufacturer.
- F. Prior to installation of the fireproofing, prepare a sample installation of at least 100 sq. ft. over a representative area on site. The sample area shall be tested for density, and bond strength to assure compliance with the submitted independent laboratory reports or the project requirements.
- G. Sprayed fireproofing shall meet requirements of systems approved by State Fire Marshal and local Building Inspector.
- H. Applicator Qualifications: Applicator shall be approved by sprayed fireproofing manufacturer, including qualified factory training where recommended by manufacturer.
- I. Fireproofing products shall be 100% free of asbestos and mineral wool fibers.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Material shall be delivered in original unopened packages, fully identified as to manufacturer, brand or other identifying data, and bearing the proper Underwriters' Laboratories, Inc. labels for fire hazard and fire-resistance classification.
- B. Material shall be stored (above ground), under cover and in a dry location until ready for use. All bags that have been exposed to water before use shall be found unsuitable for use and discarded. Stock of material is to be rotated and used prior to its expiration date.
- C. Leave seals unbroken and labels intact until time of use. Remove from job site any rejected or damaged packages found unsuitable for use. Remove from job site any bags of sprayed fireproofing materials that have been exposed to water before use.

1.6 PROJECT/SITE CONDITIONS

- A. A minimum temperature of 40 degrees F (4.4 degrees C) for air and substrate must be maintained for 24 hours before, during and for 24 hours after application of the sprayed fireproofing. If necessary for job progress, General Contractor shall provide enclosures with

heat to maintain temperatures.

- B. Contractor shall provide ventilation to allow for proper drying of the fireproofing during and subsequent to its application. In poorly ventilated areas lacking natural ventilation, forced air ventilation (minimum total air exchange rate of four times per hour) shall be employed as to cause the material to become substantially dry.
- C. Protection:
 - 1. Protect adjacent surfaces and equipment from damage by overspray, fall-out and dusting-off of sprayed fireproofing materials.
 - 2. Provide temporary enclosures to prevent spray fireproofing from contaminating air.
 - 3. Provide means to prevent damage to sprayed fireproofing from inclement weather.
 - 4. Provide tarping of all floor areas where spray fireproofing is to occur.

1.7 SEQUENCING

- A. Prior to installation of sprayed fireproofing all other trades must have completed installation of all items such as hangers, clamps, and other attachments for work suspended from, attached to, or passing through construction required to receive sprayed fireproofing.
- B. Apply sprayed fireproofing prior to installation of ducts, piping conduit, and other work preventing correct application.
- C. Apply no fireproofing to underside of steel decking until completion of concrete work.
- D. At roof decks that do not receive concrete, apply no fireproofing to underside of roof decking until completion of roofing application and until roof traffic has ceased.

1.8 GUARANTY

- A. Special Project Guaranty: Submit written guaranty, executed by Contractor and cosigned by installer, agreeing to repair/replace fireproofing work of this section, which has cracked, flaked, dusted excessively, peeled or fallen from substrate, or otherwise deteriorated to a condition where it would not perform effectively as intended for fireproofing purposes; due substantially to defective materials or workmanship and not due to abuse by occupants, improper maintenance, unforeseeable ambient exposure, or other causes beyond anticipated conditions and Contractor's/Installer's control. Guaranty period shall be two years after date of final project completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS AND PRODUCTS

- A. Acceptable Manufacturers and Products:
 - 1. Construction Products Division of W. R. Grace & Co., Products:
 - a. Monokote Type MK-6, standard density.
 - 2. Carboline.
 - 3. Isolatek International (Cafco).
 - 4. Or accepted equal.

2.2 MATERIALS

- A. The sprayed material shall be a factory-mixed, dry formulation of gypsum or Portland cement binders and lightweight aggregates mixed with water at the project site to form a slurry for conveyance and application. The fireproofing material shall be free of asbestos and mineral

wool. The cementitious fireproofing shall comply with the following physical performance standards:

1. Dry Density: 15 PCF minimum average density regardless of density indicated in referenced fire-resistive design, or greater if required to attain fire-resistance ratings indicated, as determined per ASTM E 605 or Appendix A "Alternate Method for Density Determination" of AWCI Technical Manual 12-A.
 2. Deflection: Material shall not crack or delaminate from the surface to which it is applied when tested in accordance with ASTM E759.
 3. Bond Impact: Material subject to impact tests in accordance with ASTM E760 shall not crack or delaminate from the surface to which it is applied.
 4. Bond Strength: Fireproofing material when tested in accordance with ASTM E736, shall have a minimum average bond strength of 200 psf and a minimum individual bond strength of 150 psf.
 5. Air Erosion: Maximum allowable weight loss of the fireproofing material shall be 0.005 gm./ft² when tested in accordance with ASTM E859. For laboratory tests, the minimum sprayed fire resistive material thickness shall be 0.75", the maximum dry density shall be 15 PCF. Test specimens are not prepurged by mechanically induced air velocities and the total reported weight loss shall be the total weight loss over a 24 hour period.
 6. High Speed Air Erosion: Materials to be used in plenums or ducts shall exhibit no continued erosion after four hours at an air speed of 2,500 ft./min. (29 mph) when tested in accordance with the UMC (1985) Appendix A, Section 10.116 and ASTM E859.
 7. Compressive Strength: The fireproofing shall not deform more than 10% when subjected to compressive forces of 1,000 psf when tested in accordance with ASTM E761. Minimum sprayed-on fireproofing thickness tested shall be 0.75" and the minimum dry density shall be as specified, but not less than 15 PCF.
 8. Corrosion Resistance: Steel with applied fireproofing shall be tested in accordance with ASTM E937 and shall not promote corrosion of steel.
 9. Surface Burning Characteristics: Material shall exhibit the following surface burning characteristics when tested in accordance with ASTM E84:
 10. Flame Spread 0
 11. Smoke Development 0
 12. Mold Resistance: The fireproofing material shall be tested in accordance with ASTM G21 and shall show resistance to mold growth for a period of 60 days.
 13. Combustibility: Material shall have a maximum total heat release of 20 MJ/m² ten minutes after insertion to a radiant heat flux of 75 kw/m² when tested in accordance with ASTM E1354.
- B. Spatterkote SK-3 shall be applied to all cellular decking with flat plate on the bottom prior to the application of the Monokote MK-6 fireproofing material.
- C. Mixing water shall be clean, fresh and suitable for domestic consumption and free from such amounts of mineral or organic substances as would affect the set of the fireproofing material.
- D. Provide accessories which comply with manufacturers recommendations and which meet fire resistance designs and code requirements. Such accessories include but are not limited to: bonding agents, topcoats, stud pins, metal lath, scrim and plastic netting.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Structural steel and steel deck surfaces shall be compatible with sprayed fireproofing.
1. Primed structural steel shall be tested and reported by Underwriters' Laboratories. The report shall indicate approval for the specific primer and its use on the maximum uninterrupted span of the structural steel surface. All primed structural steel shall bear

- the appropriate Underwriters' Laboratories Inc. label indicating compliance.
2. Where a corrosive environment such as where excessive moisture or free water will contact the fireproofing or fireproofed member, a coating must be applied to prevent corrosion of the steel surfaces. The coating must be applied prior to the fireproofing application. The coatings manufacturer shall certify as to the compatibility of the coating with Portland cement based products and as to the degree of corrosion protection offered. Underwriters' Laboratories, Inc. has specific Requirements when coatings are used as substrates for fireproofing materials.
 3. Rolling compounds or lubricants:
 - a. The Project Manager shall determine whether the lock-down agent and/or primer has been tested in accordance with ASTM E119 with the specified sprayed replacement fireproofing material to provide the required fire resistant rating.
 - b. Steel surfaces that have been sprayed with a lock-down agent and/or primer will require a fireproofing bond test to determine if the lock-down formulation or primer will impair proper adhesion. Determination of the compatibility for the lock-down agent and/or primer with the sprayed fireproofing shall be the responsibility of the lock-down and/or primer manufacturer.
- B. Application of the fireproofing shall not begin until the contractor, applicator, and fireproofing testing laboratory (inspector) have examined surfaces to receive fireproofing and determined that the surfaces are acceptable to receive the fireproofing material.

3.2 PREPARATION

- A. All surfaces to receive sprayed fireproofing shall be free of oil, grease, rolling compounds or lubricants, loose mill scale, excess rust, noncompatible primer, lock down agent, dirt or any other foreign substances that will impair proper adhesion of the fireproofing to the substrate. Where necessary, cleaning of surfaces to receive fireproofing shall be the responsibility of the General Contractor.
- B. Prior to application of fireproofing, clips, hangers, support sleeves and other attachments required to penetrate the fireproofing shall be in place.
- C. Ducts, piping, equipment or other suspended matter which would interfere with application of fireproofing materials shall not be positioned until fireproofing work is complete.
- D. Prior to application of the fireproofing to the underside of roof decks, all roofing applications shall be completed. All roof traffic shall be prohibited upon commencement of the fireproofing application and until the fireproofing material is cured and fully dried.
- E. Prior to application of the fireproofing to the underside of steel decking, concrete work above shall be complete.
- F. Provide masking, drop cloths or other satisfactory coverings so as to prevent overspray of sprayed fireproofing.
- G. Where concrete, masonry or other surfaces subject to overspray are to remain permanently exposed, they shall be protected with masking, drop cloths or other satisfactory coverings.
- H. Fireproofing is slippery when wet. The General Contractor and Applicator shall be responsible for posting appropriate cautionary SLIPPERY WHEN WET signs. Signs shall be posted in all areas in contact with wet fireproofing material. In addition, the General Contractor shall be responsible for appropriate barriers to prevent entry by non-fireproofing workers into the fireproofing spray and mixer areas or other areas exposed to wet fireproofing material.

- I. Prior to application of the fireproofing material to all concrete substrates, a bonding agent approved by the fireproofing material manufacturer, shall be applied.

3.3 APPLICATION

- A. Equipment and application procedure shall conform to the material manufacturer's application instructions.
- B. Apply sprayed fire resistive material that is identical to products tested as specified in Part 1 under *Test Data* in *Submittals* article, with respect to use of sealers, topcoats, tamping, troweling, water overspray or other materials and procedures affecting the test results.
- C. Maintain ambient conditions during installation and for cure period following installation, as recommended by manufacturer. Provide ventilation and avoid excessive rate of drying. Protect from exposure to sun.
- D. Utilize probes or other approved means to determine thickness during application.

3.4 FIELD QUALITY CONTROL

- A. The County will pay an independent testing laboratory to sample and verify the thickness and density of the fireproofing in accordance with provisions of ASTM E605, "Standard Test Methods for Thickness and Density of Sprayed Fire-Resistive Materials Applied to Structural Members," the "Inspection Procedure for Field-Applied Sprayed Fire Protection Materials" as published by the AWCI. Where density samples are of irregular shape, a displacement method approved by Underwriters Laboratories Inc. shall be used to determine in place fireproofing density.
- B. County will pay an independent testing laboratory to randomly sample and verify the bond strength of the fireproofing in accordance with provisions of ASTM E736.
- C. The results of the above tests shall be made available to all parties at the completion of each floor.
- D. Areas not in compliance will be reported for proper repair. The Contractor shall patch areas from which testing samples have been removed.
- E. Repair or replace fireproofing found (by field tests) to be below compliance requirements. Add extra course of fireproofing material where feasible to achieve compliance; otherwise remove course and replace with newly installed complying work.

3.5 CLEANING

- A. After the completion of fireproofing work, application equipment shall be removed.
- B. Floors, walls, and other adjacent surfaces shall be left in a clean condition.
- C. Immediately upon completion of spraying operations in each containable area of project, remove over-spray and fall-out of materials from surfaces of the work, and clean surfaces to remove evidence of soiling. Repair or replace damaged work to restore surfaces to acceptable condition.

3.6 PATCHING

- A. Maintain protection of structure afforded by fireproofing by patching any areas which have

been removed or damaged.

- B. All patching and repairing of spray-applied fireproofing, due to damage by other trades, shall be performed with same materials under this section, and paid for by the trade(s) responsible for the damage.

3.7 PROTECTION

- A. Protection: Installer of sprayed-on fireproofing shall advise Contractor of protection requirements for fireproofing work, which will ensure that fireproofing will be substantially without damage or deterioration at time of final completion of project. Provide protection from reasonably predictable harmful exposures. Repair or replace work which has not been successfully protected.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Sealants.
- B. Primers.
- C. Bond breakers.
- D. Backstops.
- E. Cleaning Solvents.

1.2 REFERENCES

- A. Unless otherwise noted, standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes as of the date of issue of this Project Manual.
- B. Referenced Standards:
 - 1. ASTM C510 – Standard Test Method for Staining and Color Change of Single or Multicomponent Joint Sealants.
 - 2. ASTM C661 – Standard Test Method for Indentation Hardness of Elastomeric-Type Sealants by Means of a Durometer.
 - 3. ASTM C719 – Standard Test Method for Adhesion and Cohesion of Elastomeric Joint Sealants Under Cyclic Movement (Hockman Cycle)
 - 4. ASTM C794 – Standard Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants.
 - 5. ASTM C834 – Standard Specification for Latex Sealants.
 - 6. ASTM C919 – Standard Practice for Use of Sealants in Acoustical Applications.
 - 7. ASTM C920 – Standard Specification for Elastomeric Joint Sealants.
 - 8. ASTM C1184 – Standard Specification for Structural Silicone Sealants.
 - 9. ASTM C1193 – Standard Guide for use of Joint Sealants.
 - 10. ASTM C1311 – Standard Specification for Solvent Release Sealants.
 - 11. ASTM D4586 – Standard Specification for Asphalt Roof Cement, Asbestos-Free.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's descriptive literature and product specification for each product.
- B. Samples: Submit manufacturer's standard color ranges of exposed sealant materials for Architect's selection.
- C. Quality Assurance/Control Submittals:
 - 1. Product validation/assurance submittals.
 - 2. Manufacturer's laboratory adhesion and stain testing results.
 - 3. Joint sealants field adhesion to joint substrates test results.
- D. Closeout Submittals:
 - 1. Cleaning and maintenance data.

1.4 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Manufacturer Qualifications: Firm specializing in manufacturing products specified in this Section.
 - 2. Applicator Qualifications: Firm specializing in installing work specified in this Section with experience on at least 5 projects of similar nature in past 3 years.
- B. Product Validation/Assurance: Provide products with current SWRI Validation or provide independent third-party laboratory test results showing product meets performance requirements in accordance with ASTM C920 and as specified in this Section.
- C. Manufacturer Adhesion and Stain Testing: Provide manufacturer's laboratory adhesion (per ASTM C719 and C794) and stain testing (per ASTM C510) using specimens of actual substrates to ensure sealant compatibility with substrate before product acceptance.
- D. Joint Sealants Field Test for Adhesion to Joint Substrates: Perform field tests for each elastomeric joint sealant with the manufacturer's representative present prior to installation as follows:
 - 1. Install joint sealants in 5 foot joint lengths. Allow sealant to fully cure before testing.
 - 2. Make a knife cut of the sealant across the joint and along each side of the joint approximately 3 inches long.
 - 3. Place a mark on the sealant tab, 1 inch from the adhered joint to the tab's free end.
 - 4. Grasp a 2 inch piece of sealant firmly just beyond the 1 inch mark and pull at a 90 degree angle.
 - 5. Record whether or not sealant in joint maintained adhesion to substrate or not.
 - 6. Record percentage length of sealant elongation.
 - 7. Sealant product acceptance shall be based on pass/fail adhesion performance.
- E. Coordination and Pre-Installation Meetings:
 - 1. Convene pre-installation meeting prior to commencing work of this Section.
 - 2. Coordinate work in this Section with work in related Sections.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in the unopened, original containers or unopened packages with manufacturer's name, labels, product identification, color, expiration period, curing time and mixing instructions for multi-component materials.
- B. Storage and Protection: Store materials in a dry secure place at temperatures below 80 degrees F.

1.6 PROJECT/SITE CONDITIONS

- A. Maintain temperature and humidity conditions as recommended by sealant manufacturer. Apply solvent curing sealants in well ventilated spaces.

1.7 SEQUENCING

- A. Apply waterproofing, water repellents, and preservative finishes after sealant installation has fully cured.

1.8 WARRANTY

- A. Provide manufacturer's warranty against material defects, air and water tightness, loss of

adhesion, cohesion, and staining as follows:

1. Silicone sealants – 20 years.
2. Urethane sealants – 5 years.
3. Other sealants – 2 years.

B. Provide installer's warranty against workmanship for 2 years.

1.9 MAINTENANCE DATA

A. Provide cleaning and maintenance information.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Dow Corning Corp.
- B. GE Silicones
- C. Pecora Corp.
- D. Sika Corporation
- E. Tremco Inc.
- F. BASF Corporation – Building Systems
- G. Or accepted equal.

2.2 SEALANTS

- A. General:
 1. Provide sealants that have been tested and found suitable for the substrates to which it will be applied.
 2. Color: As selected by Architect from manufacturer's full range of colors.
- B. Interior Building Sealant (Interior Joints at non-detention areas): Siliconized acrylic latex sealant; ASTM C834; single component; mildew resistant; paintable.
 1. Tremco Inc. Tremflex 834.
 2. Pecora Corp. AC-20 + Silicone.
 3. or accepted equal.
- C. Sanitary Sealant (interior joints with nonporous substrates around non-detention ceramic tile, showers, sinks and plumbing fixtures): Mildew resistant silicone sealant; ASTM C920; Type S; Grade NS; Class 25; use NT, G, A, and O; formulated with fungicide.
 1. Tremco Inc. Tremsil 200 Sanitary.
 2. Pecora Corp. Pecora 898.
 3. Dow Corning Corp. 785 Mildew Resistant
 4. GE Silicones Sanitary SCS 1700.
 5. or accepted equal.
- D. Exterior Perimeter Sealant (at non-detention areas): Silicone sealant; ASTM C920, Type S; Grade NS; Class 25; use NT, M, G, A, and O. Acceptable products:
 1. Tremco Inc. Spectrem 1.
 2. Dow Corning Corp. 790 Silicone Building Sealant.

3. Pecora Corp. Pecora 890NST.
 4. or accepted equal.
- E. Exterior Perimeter Sealant (at non-detention areas): Polyurethane sealant; ASTM C920; Type S or M; Grade NS; Class 25; use NT, M, A, G, and O. Acceptable products:
1. Tremco, Inc. Dymeric 240FC.
 2. BASF MasterSeal NP150 Tint Base.
 3. or accepted equal.
- F. Security Sealant: Type II; ASTM C881, Grade NS; two-part, 100% solids, moisture tolerant, low-modulus, non-sag, paste-consistency epoxy resin binder for use in horizontal and vertical joints; "Sikadur 23" Security Sealant as manufactured by Sika or accepted equal.
1. Use at all exposed areas subject to contact by inmates including but not limited to the following:
 - a. Detention doors and frames.
 - b. Detention furnishings and accessories.
 - c. Security plumbing and electrical fixtures.
 - d. Exposed decking and deck seams/joints.
 - e. Seams in cells and mezzanine.
 - f. Security electronic devices.
 - g. Transaction units.
- G. Security Sealant: Grade NS; two-part, non-sagging, solvent-free, moisture tolerant, flexible epoxy control joint sealer and adhesive for use in horizontal and vertical joints; "Sikadur 51" Security Sealant as manufactured by Sika or accepted equal.
1. Use at all exposed areas subject to contact by inmates including but not limited to the following:
 - a. Wall to decking intersections.
 - b. Guardrail and railing joints and seams.
 - c. Concrete masonry unit control joints at interiors.
- H. Self-Leveling Polyurethane Sealant (concrete paving and flatwork): ASTM C920; Type M; Grade P; Class 25; use T and M. Acceptable products:
1. Tremco, Inc. THC 900.
 2. Pecora Corp. Urexpam NR-200.
 3. BASF MasterSeal SL 2.
 4. or accepted equal.
- I. Bedding thresholds, glazing secondary seals, curtain wall joints, sheet metal flashing and trims (not exposed to ultraviolet (UV) light): Blend of butyl rubber and polyisobutylene flexible sealant; ASTM C1311. Acceptable products:
1. Tremco, Inc. Butyl Sealant.
 2. Pecora Corp. BA-98 Butyl Rubber Sealant.
 3. or accepted equal.

2.3 ACCESSORIES

- A. Primers: Nonstaining, quick-drying type and consistency recommended by the sealant manufacturer for the particular application.
- B. Bond Breakers: Type and consistency recommended by the sealant manufacturer for the particular application.
- C. Bond Breaker Tape: Self-adhesive, polyethylene tape.

- D. Joint Backing: Non-adhering backing to sealant; nonstaining, compatible with sealant and primer such as round, closed cell polyethylene foam rod; oversized 30 percent to 50 percent larger than joint width. Materials impregnated with oil, bitumen or similar materials are not permitted.
- E. Joint Cleaner: Non-corrosive and nonstaining type, recommended by sealant manufacturer and compatible with joint forming materials.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine job site conditions; verify substrate, surfaces, and joint openings are ready to receive work and field measurements are as shown on drawings, as specified in this Section, and as recommended by manufacturer.
- B. Report unacceptable conditions to Project Manager. Begin installation only when unacceptable conditions have been corrected.

3.2 PREPARATION

- A. Clean, prepare, and prime joints in accordance with manufacturer's instructions.
- B. Remove loose materials and foreign matter that might impair sealant adhesion. Clean porous materials such as concrete or masonry by grinding, sand or water blast cleaning, mechanical abrading, acid washing or a combination of these methods as required to provide a clean, sound base surface for sealant adhesion.
 - 1. Remove laitance by acid washing, grinding or mechanical abrading.
 - 2. Remove form oils, release agents, chemical retardants, by sand or water blast cleaning.
 - 3. Blow out joints with oil-free compressed air loose particles resulting from grinding, abrading, or blast cleaning prior to sealant application.
 - 4. Do not apply sealant to masonry joints where water repellent or masonry preservative has been applied. Apply water repellents or waterproofing treatments after sealants has fully cured. Coordinate with Section 07 19 19 "Silicone Water Repellents".
- C. Mechanically or chemically clean nonporous surfaces such as metal and glass. Remove temporary protective coatings on metallic surfaces using solvents that leave no residue as recommended by metal surface manufacturer. When masking tape or strippable films are used, remove the tape or film and clean any residual adhesive. Apply and wipe-dry cleaning solvents using clean, lint-free cloths or paper towels, do not allow solvent to air dry without wiping.
- D. Protect elements surrounding the work of this Section from damage or disfiguration.

3.3 APPLICATION

- A. Apply sealants in accordance with ASTM C1193, manufacturer's instructions, and accepted shop drawings.
- B. Apply acoustical sealants in accordance with ASTM C919, manufacturer's instructions, and accepted shop drawings.
- C. Apply sealant where indicated on the drawings and at all exterior joints and openings in the building envelope that are observable sources of air or water infiltration.

- D. Measure joint dimensions and size materials to achieve required width-to-depth ratios.
Acceptable joint width-to-depth ratios:

Material	Joint Width	Joint Depth	
		Minimum	Maximum
Metal, glass, or other nonporous surfaces.	1/4 inch (minimum)	1/4 inch	1/4 inch
	Over 1/4 inch	1/2 of width	Equal to width
Wood, concrete, masonry, or other porous surfaces.	1/4 inch (minimum)	1/4 inch	1/4 inch
	Over 1/4 inch	1/2 of width	Equal to width
	Over 1/2 to 2 inches	1/2 inch	1/2 inch
	Over 2 inches	As recommended by sealant manufacturer.	

- E. Install joint backing to achieve desired joint width-to-depth ratio. Roll the material into the joint to avoid lengthwise stretching. Do not twist or braid rod stock.
- F. Install bond breaker where joint backing is not used.
- G. Prime surfaces to receive joint sealant with primer recommended by sealant manufacturer.
- H. Apply sealant within recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges. Apply masking tape where required to protect adjacent surfaces from sealant application.
- I. Install sealant free of air pockets, foreign embedded matter, ridges, and sags.
- J. Tool joints concave. Use dry tooling method.

3.4 CLEANING AND REPAIRING

- A. Immediately clean work under provisions of Section 01 70 00 "Execution and Closeout Requirements".
- B. Clean adjacent soiled surfaces. Use a solvent or cleaning agent as recommended by the sealant manufacturer. Remove any masking tape immediately after tooling joints, leaving finished work in neat and clean condition.
- C. Repair or replace defaced or disfigured caused by work of this Section.

3.5 PROTECTION OF FINISHED WORK

- A. Protect finished installation under provisions of Section 01 50 00 "Temporary Facilities and Controls".
- B. Protect sealant until cured.
- C. Do not paint sealants until sealant is fully cured.

- D. Do not paint silicone sealant.
- E. Protect joint sealants from contact with contaminating substances and from damage. Cut out, remove and replace contaminated or damaged sealants, immediately, so that they are without contamination or damage at time of substantial completion

END OF SECTION

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes: Provide shop fabricated elastomeric expansion joint cover assemblies, metal and elastomeric types as indicated, including anchors and accessories as required for complete installation.
 - 1. Provide weather-tight exterior joint cover assemblies, with metal retainers, including anchors and accessories as required for complete installation.

1.2 SYSTEM DESCRIPTION

- A. System Responsibility: Provide each type of joint cover assembly as a system from a single manufacturer; provide exterior wall and roof joint cover assemblies from a single manufacturer.
 - 1. Provide factory-fabricated connection between exterior wall and roof joint covers.
- B. Field Measurements: Take field measurements prior to preparation of shop drawings and fabrication, where possible.
 - 1. Allow for trimming and fitting wherever taking of field measurements before fabrication might delay work.
 - 2. Furnish setting drawings for installation of anchorages to be embedded in adjacent construction; coordinate delivery of such items to Project site so as to prevent delay of construction.
- C. Fire Rated Assemblies: Provide systems listed or certified by Underwriters Laboratories (UL), or similar independent testing laboratory accepted by applicable authorities.
- D. Shop Assembly: Assemble items in shop to minimize field splicing and assembly of units at Project site.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's literature for each joint cover assembly.
- B. Shop Drawings: Indicate method of connection to structure.
- C. Samples: Submit samples of each type of exposed finish material.
- D. Certificates: Submit manufacturer representative's certification indicating exterior joint cover assemblies have been installed in accordance with manufacturer recommendations and instructions.

1.4 WARRANTY

- A. Special Warranty: Provide for correcting failure of exterior expansion and compression joint cover assemblies to maintain weather-tight closure under anticipated movement and conditions.
 - 1. Warranty Period: Five years.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Construction Specialties, Inc. C-S Group. Product: SF 400
- B. Balco/Metallines, Inc.
- C. MM Systems, Inc.
- D. Michael Rizza Co., Inc.
- E. Or accepted equal.

2.2 MATERIALS

- A. Aluminum: ASTM B221 alloy 6063-T5 for extrusions; ASTM B209, alloy 6061-T6, sheet and plate
 - 1. Metal Finishes:
 - a. Aluminum Contact Surfaces on Concrete: Zinc chromate primer.
 - b. Other Aluminum: Manufacturer's standard satin, clear anodic coating.
 - 2. Wearing Surfaces: Manufacturer's standard, of type shown on Drawings.
 - 3. Protection: Cover exposed metal surfaces with factory-applied adhesive paper or polyvinyl chloride (PVC) protective strippable coating.
- B. Elastomeric Seals: Manufacturer's standard durometer consistent with joint size and application.
 - 1. Functional Seal: ASTM C509 closed cell neoprene as recommended by manufacturer for application indicated and as needed to assure weathertight exterior applications.
 - 2. Visual Seals: ASTM C864 dense silicone; color as selected by Architect from manufacturer's full range of available colors.
 - 3. Lubricants/Adhesives: Type as recommended by system manufacturer for specific material and application.
 - 4. Sealants at Elastomeric Seals: Type as recommended by seal manufacturer to maintain integrity of weather barrier.
- C. Accessories: Manufacturer's standard anchors, fasteners, set screws, spacers, flexible seal and filler materials, adhesive and accessories compatible with material in contact.
 - 1. Exterior Anchors: Minimum Series 300 stainless steel.
 - 2. Elastomeric Seal Corner Angle Reinforcing: Minimum Series 304 stainless steel.
- D. Fire Rated Assemblies: Provide complete assemblies complying with requirements for fire ratings matching adjacent construction, and matching construction of listed or approved rated assemblies.
 - 1. Smoke Barriers: Provide fire rated assemblies capable of providing smoke barrier in accordance with applicable code requirements.

2.3 FABRICATION

- A. General: Furnish basic profile and operating units for expansion joint covers as indicated on Drawings.
 - 1. Expansion and Compression Joint Cover Types: As indicated and as approved by Architect.
- B. Furnish longest practicable lengths to minimize number of end joints.

1. Seals: Continuous between intersections with joints mitered, reinforced with stainless steel angles, and sealed with joint sealer.
 2. Functional Seals: Continuous where possible.
 3. Intermediate Drains: Provide at exterior joint cover assemblies as required to allow water to drain to exterior.
 4. Interior Seals: Continuous between intersections with joints mitered. Reinforce joints with stainless steel angles.
 5. Design, fabricate, and install exterior joint cover assemblies to be weather-tight.
- C. Provide hairline mitered corners where joint changes direction or abuts other material systems.
- D. Provide factory fabricated custom fit end closers at exposed ends of joint cover assemblies.
- E. Provide separator coat between aluminum and dissimilar materials to prevent electrolysis and to protect aluminum.

PART 3 EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which expansion joint covers are to be installed.
- B. Coordinate with adjacent systems to ensure acceptable conditions for installation of expansion joint cover assemblies.
- C. Do not proceed with work until unsatisfactory conditions have been corrected, start of installation indicated acceptance of conditions.

3.2 INSTALLATION

- A. Manufacturer's Instructions: Comply with manufacturer's instructions and recommendations,
- B. including preparation of substrate, applying materials and protection of installed units.
 1. Fire Rated Assemblies: Install assemblies using materials and methods as required to provide fire resistant rating matching adjacent material and assembly ratings.
- C. B. Cutting, Fitting and Placement:
 1. Perform cutting, drilling and fitting required for installation.
 2. Set work accurately in location, alignment and elevation, plumb, level, true, measured from established lines and levels.
 3. Provide temporary bracing or anchors in formwork for items which are to be built into concrete, masonry or similar construction.
 4. Install joint cover assemblies in true alignment.
 5. Hold end joints to minimum; make end joints with strong, rigid, mechanical splice plate in true alignment, with hairline joints.

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Services: Manufacturer's representative to visit site and provide written certification indicating exterior expansion joint covers have been installed in accordance with manufacturer recommendations and instructions.
- B. Exterior Joint Covers Water Test: Clean intermediate drains and test to ensure water does flow through expansion joint cover drainage system and is properly directed to building

drainage or to building exterior.

3.4 CLEANING AND PROTECTION

- A. Do not remove strippable protective material until finish work in adjacent areas is complete.
- B. When protective material is removed, clean exposed metal surfaces in accordance with manufacturer's instructions.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Non-Detention Hollow metal doors and frames.

1.2 REFERENCES

- A. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- B. Referenced Standards:
 - 1. ANSI/SDI A250.6 – Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames.
 - 2. ANSI/SDI A250.8 – Standard Steel Doors and Frames.
 - 3. ASTM A653/A653M – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - 4. ASTM A1008/A1008M – Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
 - 5. ASTM A1011/A1011M – Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
 - 6. ASTM C578 – Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
 - 7. ASTM E283 – Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
 - 8. ANSI/NAAMM HMMA 861 – Guide Specifications for Commercial Hollow Metal Doors and Frames.
 - 9. California Building Code, Section 716 “Opening Protectives,” Paragraph 716.5 “Fire Door and Shutter Assemblies”.
 - 10. NAAMM HMMA 840 – Guide Specification for Installation and Storage of Hollow Metal Doors and Frames.
 - 11. NFPA 80 – Standard for Fire Doors and Other Opening Protectives.
 - 12. NFPA 105 – Standard for the Installation of Smoke Door Assemblies and Other Opening Protectives.
 - 13. NFPA 252 – Standard Methods of Fire Tests of Door Assemblies.
 - 14. NFPA 257 – Standard on Fire Test for Window and Glass Block Assemblies.
 - 15. NFRC 400 – Procedure for Determining Fenestration Product Air Leakage.
 - 16. UL 9 – Standard for Safety Fire Tests of Window Assemblies.
 - 17. UL 10B – Fire Tests of Door Assemblies.
 - 18. UL 10C – Positive Pressure Fire Tests of Door Assemblies.
 - 19. UL 1784 – Air Leakage Tests for Door Assemblies.

1.3 SUBMITTALS

- A. Shop Drawings: Include illustrations and schedule of finish hardware, door and frame size, type, material, fire ratings, construction, finishing, anchoring, glazing, louvers, accessories, and preparation for installing hardware.
 - 1. Method of attachment of frames to structure shall be reviewed by Architect for acceptance or rejection.
 - 2. Details of conduit and preparations for power, signal, and control systems.

- B. Templates: Furnish hardware templates to fabricator of frames to be factory prepared for installation of hardware.
- C. Submit product data for type of metal primer proposed for use.

1.4 DEFINITIONS

- A. Minimum Thickness: Minimum thickness of base metal without coatings.
- B. Standard Hollow Metal Work: Hollow metal work fabricated according to ANSI/SDI A250.8.

1.5 QUALITY ASSURANCE

- A. Steel door and frame manufacturer shall be SDI certified.
- B. Provide doors and frames complying with ANSI A250.8, ANSI/NAAMM-HMMA 861, and as specified herein.

1.6 REGULATORY REQUIREMENTS

- A. Fire-Rated Doors and Frames: Provide doors and frames complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.
 - 1. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
 - 2. Temperature-Rise Limit: At vertical exit enclosures and exit passageways, provide doors that have a maximum transmitted temperature end point of not more than 450 degrees F above ambient after thirty minutes of standard fire-test exposure.
- B. Testing of Fire-Rated Door and Frame Assembly: Conform to applicable requirements of NFPA 252 or UL 10C.
- C. Doors and Frames for Smoke-Control Door Assemblies: Comply with applicable requirements of NFPA 105 or UL 1784.
- D. Fire-Rated Door and Frame Labels: All fire rated doors and frames shall have metal labels (including "S" labels) permanently fastened to the jamb indicating the fire rating and Testing Agency name.
 - 1. Do not apply primer or paint over fire rating labels.
- E. Fire-Rated, Borrowed-Light Frame Assemblies: Assemblies complying with NFPA 80 that are listed and labeled, by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 257 or UL 9. Label each individual glazed lite.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Deliver all materials under protective cover and store in upright position within a dry enclosed space in a manner that will prevent rust and damage. Do not create a humidity chamber by using a plastic or canvas shelter that is not adequately vented.
- B. Deliver fully-welded frames with two removable spreader bars across bottom of door frames, tack welded to jambs and mullions.

1.8 PROJECT CONDITIONS

- A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.9 COORDINATION

- A. Coordinate installation of anchorages for hollow metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers, Hollow Metal Doors and Frames:
 - 1. Ceco Door Products
 - 2. Curries Company
 - 3. Steelcraft
 - 4. Door Components Inc.
- B. Or accepted equal.

2.2 MATERIALS

- A. Cold-Rolled Steel Sheets for Doors and Frames: Commercial Steel (CS), Type B, complying with ASTM A1008/A1008M.
 - 1. Use cold-rolled steel for door frames and exposed-to-view surfaces.
- B. Hot-Rolled Steel Sheets and Strip for use at Door Frames: Commercial Steel (CS), Type B; complying with ASTM A1011/A1011M.
 - 1. Steel shall be free of mill scales, pitting, or surface defects; pickled and oiled.
 - 2. Use hot-rolled steel for reinforcement and concealed components only.
- C. Factory-Applied Primer: Manufacturer's standard primer, thickness: two mils minimum, and compatible with ferrous and galvanized metal primers.

2.3 STANDARD HOLLOW METAL DOOR FABRICATION

- A. General: Fabricate to sizes shown, providing necessary clearances and bevels to permit operation without binding. Doors shall be free from warp, wave, buckle or other defect. Doors shall be 1-3/4 inches thick, unless otherwise indicated on Drawings.
- B. Flush Door Construction: Door shall be Grade III, Model 2, fabricated with face sheets of 16 gauge steel in accordance with ANSI/SDI A250.8 and galvanized to ASTM A653/A653M A60 at exterior locations and interior wet locations. Door shall be flush with edge seams, weld filled and ground smooth. Bevel lock edge 1/8 inch in 2 inches. Door shall be provided with 16 gauge steel top flush cap welded and ground smooth, and bottom inverted 14 gauge steel channels welded within the door. Door shall be reinforced, stiffened and sound deadened with impregnated kraft honeycomb core completely filling door cavity, and laminated to the inside faces of panels.
 - 1. Exterior doors shall be insulated with an expanded polystyrene or polyurethane core, or as standard with manufacturer. Completely fill door cavity with insulation. Expanded polystyrene to be ASTM C578, Type 1 or Type 2, with minimum one pound per cubic

foot density.

- C. Preparation of Hardware: Per ANSI/SDI A250.6, door shall be mortised, reinforced, drilled and tapped at the factory from templates for all mortise hardware listed in the Hardware Schedule. Door shall be reinforced for surface applied hardware such as closers, checks, escutcheons and kick plates; drilling and tapping to be done in the field by door installer. Reinforcement to be 12 gauge for locksets and latchsets, and 14 gauge for surface applied hardware, except use 3/16-inch thick plate for butt hinges. Door shall be provided with reinforcing unit as recommended by lock manufacturer.

2.4 STANDARD HOLLOW METAL FRAME FABRICATION

- A. General:
 - 1. Provide fully-welded frames.
 - 2. Hollow metal frames shall be formed to shapes and sizes shown.
- B. Full Profile Welded Frames: Head and jamb splices shall be fabricated with mitered, coped and continuously welded inside and outside corners and be finished on the outside face to present a smooth surface for painting.
- C. Frames shall be fabricated from 16 gauge steel at interior locations and 16 gauge stainless steel at exterior locations, and shall be designed with integral stop and trim. All corners shall be reinforced with 18 gauge "L" shaped reinforcements welded on the inside face of the frame.
 - 1. Provide steel reinforcement at steel frames.
 - 2. Provide stainless steel reinforcement at stainless steel frames.
- D. Reinforce frames wider than 48 inches with roll formed channels fitted tightly into frame head, flush with top.
 - 1. Provide steel channels at steel frames.
 - 2. Provide stainless steel channels at stainless steel frames.
- E. Frames shall be hot-dipped galvanized to ASTM A653/A653M G90 at interior wet locations.
- F. Preparation for Hardware: Frame shall be prepared at the factory for all hardware using templates furnished by hardware supplier. Locations of miscellaneous hardware shall conform to the recommendations for the Door & Hardware Institute. Mortise, reinforce, drill and tap for mortise type hardware. Reinforce frames for surface applied hardware; drilling and tapping to be done in the field by door installer.
 - 1. Hardware cutouts shall have steel plate reinforcements with tapped holes fillet welded to frame on all four sides of the plate. Fillet welds shall be minimum 1 inch long. Reinforcement shall include 3/16 inch butt reinforcement; 12 gauge lock strike; 14 gauge for surface applied items.
 - a. Provide stainless steel reinforcement at stainless steel frames in the locations and thickness specified above.
 - 2. Provide strike stops at frames to receive metal doors with holes for three rubber door silencers. On double door frames, provide for two silencers per door at head. Omit holes at frames to receive unitized gasketing.
- G. Where the solid grouting of frames is required, provide top openings and jamb to mullion openings to facilitate the solid grouting of frames.

2.5 BORROWED LIGHTS (INTERIOR WINDOWS, FIXED)

- A. Interior Window Units: Furnish shop assembled and welded units for fixed windows, fabricated to the designs and dimensions indicated. Provide metal glazing stops and mouldings of same gauge as frame on secure side of window for field assembly with countersunk oval head self-tapping screws spaced not over 16 inches on center. Frames shall be complete with all corners welded, ground smooth, and provided with anchors.

2.6 ANCHORS

- A. Frame shall be anchored to structure with anchors appropriate for use with type of adjacent construction. Anchorage shall securely fasten frames to wall construction involved. Provide a minimum three anchors, including one adjustable floor anchor, at each door jamb. Frames taller than eight feet in height will require additional anchors at each jamb. Anchors shall be minimum 16 gauge steel and shall provide stiffness and rigidity to keep frames square, in accurate position without twisting, buckling or warping. Fasteners to framing substrate shall be the following minimums; greater as required by the frame manufacturer or as conditions warrant:
 - 1. Metal Framing: Two #10 self-tapping sheet metal screws per anchor, length as required; fastener to penetrate a minimum of 1/4 inch into framing member.
 - 2. Masonry: 3/8 inch diameter loop anchors welded to the 10 gauge steel plates. Refer to Drawings for size, location, and quantity.

2.7 PRIMING

- A. Doors and frames shall be leveled and welds ground smooth. Apply mineral filler to eliminate weld scars and other blemishes.
- B. Shop Priming: All surfaces shall be cleaned, phosphatized, and given one coat of baked-on rust-inhibiting primer in accordance with the Steel Door Institute Specification "Test Procedure and Acceptance Criteria for Primer Painted Steel Doors and Frames".
 - 1. Do not prime paint over fire-rated door and frame labels.

2.8 ACCESSORIES

- A. Glazing Stops: LoPro by Anemostat or Slimline by Air Louvers, Inc. Galvanized steel; mitered corners; prepared for countersink style screws. Sizes as indicated on Drawings. Install glazing stop fasteners on the non-secure side of doors. Finish shall be factory primed to receive site paint finish, color as selected by Architect.
 - 1. At fire-rated assemblies, fire-rating of glazing stops shall match fire-rating of opening. Fire-rated glazing stops shall bear the listing mark of Underwriters Laboratories and/or Warnock Hersey, and shall be visible without removal of the frame from the door.
- B. Non-Rated Door Louvers: AFDL by Anemostat or Model 800 A1 by Air Louvers, Inc. Fabricate from galvanized cold rolled steel sheet. Frame shall be 18 gauge and blades shall be 22 gauge. Permanent interlocking construction shall be used to secure blades to frame on stationary louvers. Frames shall have mitered and flush welded corners. Factory install screens, aluminum wire mesh. Louvers shall have fifty percent free area minimum; sizes as indicated on Drawings. Finish shall be factory primed to receive site paint finish, color as selected by Architect.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that opening sizes and tolerances are acceptable.

3.2 INSTALLATION

- A. Install doors and frames in accordance with ANSI A250.8, and ANSI/NAAMM-HMMA 861, and UL 752, as applicable.
- B. Set frames level and plumb, and brace adequately to prevent damage or distortion. Secure to structure with minimum of three anchors at each jamb. Field joints shall be welded, body puttied and ground smooth.
 - 1. Removable Spreaders: Wherever possible, leave frame spreaders intact until frames are set perfectly square and plumb, and anchors are securely attached.
- C. Door Installation in Hollow Metal Frames: Fit hollow metal and wood doors accurately in frames.
- D. Door frames that are not filled with grout (in CMU walls) shall have the inside filled with **fiberglass** acoustic insulation. Do not compress insulation.

3.3 ERECTION TOLERANCES

- A. Maximum Diagonal Distortion: 1/16 inch measured with straight edge, corner to corner.

3.4 ADJUST AND CLEAN

- A. Prime Coat Touch-Up: Immediately after erection, sand smooth all rusted or damaged areas of prime coat and apply touch-up of compatible air-drying primer. Touch-up shall not be obvious.
- B. Cleaning and Finishing: Upon completion of the work, clean all exposed surfaces, removing any discoloration or foreign matter, and touch up all abraded or cut areas and exposed edges with finishing material recommended by the manufacturer. Touch-up of finish shall not be obvious.
- C. Final Adjustments: Adjust door for smooth and balanced door movement. Check and readjust operating finish hardware in hollow metal work immediately prior to final inspection. Leave work in complete and proper operating condition.
- D. Defective Work: Remove and replace defective work, including doors and frames which are warped, bowed or otherwise damaged, as directed by Architect, at no cost to Owner.
- E. Protection: Protect installed hollow metal work against damage from other construction work.

3.5 CLEAN-UP

- A. Upon completion of the work of this Section, remove all excess materials, rubbish, and debris from the premises.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Rated and Non-Rated Flush Plastic- Laminate Wood Doors.

1.2 REFERENCES

- A. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- B. Referenced Standards:
 1. ANSI/WDMA I.S.1-A Architectural Wood Flush Doors.
 2. California Building Code, Section 716 "Opening Protectives", Paragraph 716.5 "Fire Door and Shutter Assemblies".
 3. ITS Directory of Listed Products.
 4. NFPA 80 Fire Doors and Windows.
 5. NFPA 252 Standard Test Methods for Fire Door Assemblies.
 6. UL 10C Standard for Positive Pressure Fire Tests of Door Assemblies.
 7. WI/AWMAC North American Architectural Woodwork Standards, including WI Supplemental Text.

1.3 SUBMITTALS

- A. Shop Drawings: Illustrate door opening criteria, elevations, sizes, types, fire ratings, swings, undercuts required, special beveling, special blocking for hardware, and identify cutouts for glazing and louvers.
- B. Product Data: Indicate door core materials and construction, veneer species and cut, type and characteristics, factory machining criteria, and factory finishing criteria.
- C. Samples: Submit three sets of three samples each of door laminate, 8 inches x 8 inches in size.

1.4 QUALITY ASSURANCE

- A. Single Source Responsibility: All doors specified in this Section shall be manufactured and provided by a single manufacturer to ensure door compatibility and quality.
- B. Perform work in accordance with WI/AWMAC, Section 9, Custom Grade.
- C. Other requirements shall conform to WDMA I.S. 1A-04 as follows:

Performance Attribute	Duty Level
	Extra Heavy Duty
Adhesive Bond Durability WDMA TM-6, 1988	Type I
Cycle Slam WDMA TM-7, 1990	1, 000,000 cycles
Hinge-Loading WDMA TM-8, 1990	550 pounds
Screwholding WDMA TM-10, 1990	

Door Face Unblocked	550 pounds
Door Face (with optional blocking)	700 pounds
Vertical Door Edge	550 pounds
Horizontal Door Edge (applies when hardware attached)	300 pounds
Telegraph WDMA T-1	Maximum 0.010 inch per 3-inch span
Warp Tolerance WDMA T-2	Maximum 0.25 inch per 3 foot 6 inches by 7 foot door section
Squareness WDMA T-3	Diagonal Variance 0.125 inch

1.5 REGULATORY REQUIREMENTS

- A. Fire-Rated Wood Doors: Doors complying with California Building Code (CBC), and NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C, as applicable.
- B. Fire Door Construction: Conform to NFPA 252.
- C. Fire-Rated Doors: All fire rated doors shall have metal labels (including “S” labels) permanently fastened to the hinge stile indicating the fire rating and Testing Agency name. Do not apply primer or paint over fire rating labels.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the products specified in this Section.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Accept doors on site in manufacturer's packaging. Inspect for damage.
- B. Comply with requirements in ANSI/WDMA I.S.1A: How to store, handle, finish, install and maintain wood doors.
- C. In the event of damage, immediately make all repairs and replacements necessary at no additional cost to Owner.
- D. Store flat on a level surface in a dry, well-ventilated building. Cover to keep clean but allow air circulation.
- E. Handle with clean gloves and do not drag doors across one another or across other surfaces.
- F. Do not subject door to abnormal heat, dryness or humidity.
- G. Deliver in clean trucks and, in wet weather, under cover.

1.8 FIELD MEASUREMENTS

- A. Verify that field measurements are as indicated on shop drawings.

1.9 COORDINATION

- A. Coordinate the work with door opening construction, doorframe, door hardware, door glazing, and door louver installation.

1.10 WARRANTY

- A. Provide warranty under provisions of Division 01.
- B. Warranty Period:
 - 1. Interior Solid Core Standard Doors Life of installation.
 - 2. Include coverage for delamination of veneer, warping or twisting (not to exceed 1/4 inch in any face including diagonal) or other defects. Warranty shall cover replacement of door plus costs of hanging and finishing.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers:
 - 1. Weyerhaeuser Company
 - 2. Eggers Industries
 - 3. Oregon Door
 - 4. VT Industries
 - 5. Or accepted equal.

2.2 DOOR CONSTRUCTION

- A. Construction
 - 1. 5 ply hot press construction or 7 ply cold press construction.
 - 2. Core glue bonded to stiles and rails then thickness sanded prior to door lay-up. No mechanical fasteners may be used.
 - 3. Institutional solid particle board core.
 - 4. SLM edges with veneer covering and SLM blocking for hardware.
 - 5. Provide doors made with adhesives and composite wood products that do not contain urea-formaldehyde resins.
- B. Fire-Rated Doors: 1-3/4" thick, match non-rated door appearance; comply with UBC Standard 7-2; UL or Warnock Hersey rated.
 - 1. Labels: Place fire rating labels where visible when doors are installed, in opened position.
 - 2. Fire Ratings: Refer to Drawings for fire rating requirements.
 - 3. Core: Use wood core construction for 20 minute rated flush doors, mineral core permitted for longer ratings
 - 4. Temperature Rise Rating: Provide doors with maximum 450°F Temperature Rise Rating in 30 minute fire exposure period at doors into exit enclosures.
- C. Plastic Laminate Faces:
 - 1. Decorative 3-ply laminate face from the following manufacturers: Formica Nevamar or Wilsonart.
 - 2. High pressure decorative laminate general purpose grade 50 (GP50 - .050" thick). Complying with NEMA standard LD-3.
 - 3. Apply faces prior to edges, ease all corners.

2.3 ACCESSORIES

- A. Glazing Stops: LoPro by Anemostat or Slimline by Air Louvers, Inc. Steel; mitered corners; prepared for countersink style screws. Sizes as indicated on Drawings. Install glazing stop fasteners on the non-secure side of doors. Factory paint finish in custom color as selected by Architect.
 - 1. At fire-rated assemblies, fire-rating of glazing stops shall match fire-rating of opening. Fire-rated glazing stops shall bear the listing mark of Underwriters Laboratories and/or Warnock Hersey, and shall be visible without removal of the frame from the door.
- B. Non-Rated Door Louvers: Anemostat Model ADFL or Air Louver. Fabricate from cold rolled steel sheet. Frame shall be 18 gauge and blades shall be 22 gauge. Permanent interlocking construction shall be used to secure blades to frame on fixed or stationary louvers. All frames shall have mitered and flush welded corners. Louvers shall have fifty percent free air minimum; size as indicated on Drawings.

2.4 FABRICATION

- A. Fabricate non-rated doors in accordance with WI/AWMAC North American Architectural Woodwork Standards requirements.
- B. Provide blocking at top of door for closer for attachment with screws.
- C. Bond edge banding to cores.
- D. Factory machine doors for finish hardware in accordance with hardware requirements and dimensions. Do not machine for surface hardware.
- E. Undercut doors.
- F. Glass Cutouts: Provide cutouts for glass of size and shape indicated.
- G. Louver Cutouts: Provide cutouts for louvers of size and shape indicated.
- H. Factory seal top and bottom rails before shipment.
- I. Bevel both stiles 1/8 inch in 2 inches (3 degree bevel) and undersize doors 1/4 inch in width so that they swing freely and do not hinge bind.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify frame opening conditions.
- B. Verify that opening sizes and tolerances are acceptable.
- C. Do not install doors in frame openings that are not plumb or are out-of-tolerance for size or alignment.

3.2 INSTALLATION

- A. Install rated and non-rated doors in accordance with WI/AWMAC Section 9 requirements, and UL or Intertek Testing Services (ITS) requirements.

- B. Pre-adjust door height, supply doors with factory undercut.
- C. Where required, trim non-rated door width by cutting equally on both jamb edges.
- D. Where required, trim door height by cutting bottom edge to a maximum of 3/8 inch above finished floor or threshold.
- E. Pilot drill screw and bolt holes.
- F. Machine cut for hardware. Core for handsets and cylinders.

3.3 INSTALLATION TOLERANCES

- A. Maximum Diagonal Distortion (Warp): 1/4 inch measured with straight edge or taut string, corner to corner, over an imaginary 36 inch x 84 inch surface area.
- B. Maximum Vertical Distortion (Bow): 1/4 inch measured with straight edge or taut string, top to bottom, over an imaginary 36 inch x 84 inch surface area.

3.4 ADJUSTING

- A. Adjust work under provisions of Division 01.
- B. Adjust door for smooth and balanced door movement, and wipe clean.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Fire rated access doors.
- B. Non-fire-rated access doors.
- C. Medium security access doors.

1.2 REFERENCES

- A. Unless otherwise noted, standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes as of the date of issue of this Project Manual.
- B. Referenced Standards:
 - 1. ITS Directory of Listed Products.
 - 2. UL Building Materials Directory.

1.3 SUBMITTALS

- A. Product Data: Include sizes, finish, and hardware.
- B. Shop Drawing: Show scheduled locations and details of adjoining work.

1.4 PRE-INSTALLATION MEETINGS AND COORDINATION

- A. Convene pre-installation meeting prior to commencing work of this Section.
- B. Coordinate work in this Section with work in related Sections.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers:
 - 1. Nystrom Building Products
 - 2. Karp Associates, Inc.
 - 3. J.L. Industries Inc.
 - 4. Milcor, Inc.
 - 5. Or accepted equal

2.2 ACCESS DOORS

- A. Fire-Rated Access Doors at Gypsum Board:
 - 1. Product: Nystrom, Model IW, UL rating 1.5 hours (B label); ITS rating 3 hours in ceiling.
 - 2. Components:
 - a. Sizes: As shown in the drawings, 30" x 30" min.
 - b. Frame: 16 gauge steel.
 - c. Door: 20 gauge steel.
 - d. Hinge: Concealed pin hinge.
 - e. Latch: Bolt type, key operated, self-latching with automatic closer and interior latch release.
 - f. Insulation: 2 inch thick fire rated mineral fiber.
 - g. Finish: Phosphate dipped, and prime coat of rust inhibitive electrostatic powder,

baked grey enamel.

- B. Non-Rated Access Doors:
 - 1. Product: Nystrom, Model NW-S.
 - 2. Components:
 - a. Sizes: As shown in the drawings, 30" x 30" min.
 - b. Frame: 16 gauge steel.
 - c. Door: 20 gauge steel.
 - d. Hinge: Concealed pin hinge.
 - e. Latch: Bolt type, key operated, self-latching with automatic closer and interior latch release.
 - f. Insulation: 2 inch thick fire rated mineral fiber.
 - g. Finish: Phosphate dipped, and prime coat of rust inhibitive electrostatic powder, baked grey enamel.

- C. Medium Security Access Doors at all other wall and ceiling areas:
 - 1. Product: Nystrom Model MT.
 - 2. Components:
 - a. Sizes: As shown in the drawings.
 - b. Frame: 12 gauge cold rolled steel with 1 inch flange.
 - c. Door: 12 gauge cold rolled steel.
 - d. Hinge: Concealed continuous piano hinge.
 - e. Latch: Key operated cylinder lock to accept Assa Abloy cylinder.
 - f. Finish: Phosphate dipped, and prime coat of rust inhibitive electrostatic powder, baked grey enamel.

- D. Fire-Rated Security Access Doors at wall areas:
 - 1. Product: JL Industries FD Security Series.
 - 2. Components:
 - a. Sizes: As shown in the drawings, 24" x 36" min.
 - b. Frame: 14 gauge steel with 1-inch flange and welded-on masonry anchor.
 - c. Door: 2-inch thick, insulated 14 gauge steel
 - d. Hinge: continuous hinge.
 - e. Latch: Universal turn ring and key lock.
 - f. Finish: Galvannealed Steel Finish.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine job site conditions and verify field dimensions. Verify structure is plumb, level, and parallel. Verify rough openings for door and frame are correctly sized and located.
- B. Report unacceptable conditions to the Project Manager. Begin installation only when unacceptable conditions have been corrected.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's printed instructions and approved shop drawings.
- B. Install units plumb, level, and square, and free from warp or twist while maintaining dimensional tolerances and alignment with surrounding construction. Secure rigidly in place.
- C. Position unit to provide convenient access to concealed work requiring access.
- D. Secure access doors and panels rigidly in place. Anchor to structure with anchors appropriate for use with type of adjacent construction. Fasteners shall securely fasten items

to wall/ceiling construction involved. Fasteners shall provide stiffness and rigidity to keep items square, in accurate position without twisting, buckling or warping. Fasteners to framing substrate shall be the following minimums; greater as required by the access door/panel manufacturer or as conditions warrant:

1. Metal Framing: Three No.10 self-tapping sheet metal screws each side of panel by length as required to penetrate framing member 1/4 inch minimum.
2. Masonry – Anchor at frame areas only as follows:
 - a. Masonry tee anchors.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Overhead Coiling Smoke Curtains for Elevator Doors.

1.2 COORDINATION

- A. Coordinate smoke curtain assemblies with power, signal, fire-alarm, and smoke-detection systems.
- B. Coordinate elevator smoke-protective curtain assemblies with elevator hoistway door frames.
- C. Coordinate smoke-protective curtain assemblies with ceilings for operational clearances and maintenance access requirements.
- D. Coordinate smoke-protective curtain assemblies with walls for support requirements, rating continuity above ceilings, and recessed wall switches.
- E. Coordinate requirements for metal supports required for smoke-protective curtain assemblies.

1.3 SUBMITTALS

- A. Product Data: Manufacturer's product information and data sheets for each product specified in this section, including:
 - 1. Substrate preparation instructions.
 - 2. Requirements for proper storage and handling.
- B. Shop Drawings:
 - 1. Submit Manufacturer's approved shop drawings detailing the section and elevation views of each product to be installed.
- C. Warranty Information:
 - 1. Submit confirmation and details of manufacturer's warranty, extended warranty, and replacement policies.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For smoke-protective curtain assemblies to include in emergency, operation, and maintenance manuals.
- B. Field quality-control reports for required testing.

1.5 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Manufacturer: Minimum of seven (7) years experience in manufacturing draft-control curtain assemblies at a facility in the United States that have been successfully installed in compliance with requirements of authorities having jurisdiction.
 - 2. Installers: An entity that employs installers and supervisors who are trained and approved by manufacturer for both installation and maintenance of units required for this Project.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store and handle materials and products in accordance with the manufacturer's instructions and recommendations and industry standards.
- B. Store all materials in the manufacturer's original packaging until ready for installation. Protect all products from damage or exposure to adverse weather conditions.

1.7 WARRANTY

- A. **Manufacturer Warranty:** Provide manufacturer's warranty covering parts and labor costs to repair or replace part that fail to perform. Period of warranty: 1 year from date of substantial completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. **Basis of Design Manufacturer:** Smoke Guard, A CSW Industrials Company.
- B. Or Accepted Equal.

2.2 SMOKE-PROTECTIVE CURTAIN ASSEMBLIES FOR ELEVATOR ENTRANCES

- A. **Alarm-activated transparent-film smoke curtain assembly complying with ICC-ES AC77 and NFPA 105.**
 - 1. **Basis of Design Product:** Model 200, by Smoke Guard, a CSW Industrials Company.
- B. **Smoke-Protective Curtain Assemblies:** Provide smoke-protective curtains listed and labeled with the letter "S" by a qualified testing agency for smoke- and draft-control based on testing in accordance with UL 1784 without an artificial bottom seal; with maximum air-leakage rate of 3.0 cfm/sq. ft. (0.01524 cu. m/s x sq. m) of opening at 0.10 inch wg (24.9 Pa) for both ambient and elevated temperature tests in accordance with ICC-ES AC77.
- C. **Curtain Materials:** Provide manufacturer's standard curtain complying with each of the following:
 - 1. **Flame-Spread and Smoke-Developed Indexes:** No greater than 25 and 50, respectively, when tested in accordance with ASTM E84.
 - 2. **Transparent-Film Curtain:** Provide curtain of transparent film in compliance with vision panel requirements of ASME A17.1.
 - 3. **Screen Reinforcement:** Provide film with reinforcement to limit deflection or tearing.
- D. **Curtain Egress:** Provide curtain that is operable from the egress side without use of keys, tools, special knowledge, or effort in excess of the opening force requirements of authorities having jurisdiction.
 - 1. **Egress Switch:** Include switch to rewind screen into housing to comply with egress requirements of ASME A17.1.
 - a. **Switch Size and Color:** Provide switch no less than 4 by 4 inches and in contrasting color with curtain.
 - b. **Switch Operation:** Provide switch operable with a closed fist or a loose grip, not requiring finger movements in compliance with the requirements of authorities having jurisdiction.
 - c. **Switch Location:** Between 15 and 48 inches above finished floor level in compliance with forward reach requirements of authorities having jurisdiction.
 - 2. **Manual Egress:** Provide curtain allowing fail-safe manual egress with less than 15 pounds release pressure in the direction of travel.

- a. Opening Size: Provide curtain with manual egress opening of at least 32 inches in compliance with the requirements of authorities having jurisdiction.
- E. Curtain Attachment: Provide curtain that forms a pressure-resisting seal by magnetic adhesion with flexible multi-pole magnetic strips attached to longitudinal edges of film with low modulus silicone adhesive.
 - 1. Curtain Installation: Provide curtain attachment systems that do not require modification of the elevator jamb including direct or mechanical attachment.
 - 2. Elevator Door Frames: Type 430 ferritic stainless steel elevator door frames to create seal with curtain by magnetic adhesion.
 - a. Auxiliary Rails: Provide 16-gauge ASTM A240/240M, Type 430, ferritic stainless steel vertical rails above elevator door head to create seal with curtain by magnetic adhesion no less than 2 inches (51 mm) wide, 1 inch (25 mm) deep.
 - 3. Auxiliary Rails: Provide vertical rails to create seal with curtain by magnetic adhesion.
 - a. Material: 16-gauge ASTM A240/240M, Type 430, ferritic stainless steel.
 - b. Size: At least 2 inches (51 mm) wide, 1 inch (25 mm) deep.
- F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- G. Curtain Housing: Provide sheet metal housings containing support rollers and associated electronics.
 - 1. Coordinate operator wiring requirements and electrical characteristics with building electrical system.
 - 2. Housing includes electrical junction box that does require the removal of any part of the building in accordance with NFPA 70.
 - 3. Provide electrical junction box access through housing in the open condition.
 - 4. Curtain housing to contain all components required for operation.
 - 5. Housing Finish: Manufacturer's standard powder coat finish in custom RAL color.
- H. Curtain Operation: Controlled descent automatically by fail-safe, gravity-closing deployment and motorized rewind.
 - 1. Curtain deploys on activation of one of the following:
 - a. Local Smoke Detector.
 - b. Building Fire Alarm.
 - c. Testing Key Switch
 - 2. Release Mechanism: Labelled as defined by UL864.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine substrates upon which work will be installed.
 - 1. Verify related work performed under other sections is complete and in accordance with Shop Drawings.
 - 2. Verify wall surfaces and elevator door frames are acceptable for installation of smoke containment system components.

- B. Coordinate with responsible entity to perform corrective work on unsatisfactory substrates.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.
- D. Verify that locations of concealed reinforcements have been clearly marked for the installer.
- E. Locate reinforcement points and clearly mark their locations if not already done.

3.2 PREPARATION

- A. Clean surfaces prior to installation.
- B. Prepare surfaces as recommended by the manufacturer for achieving optimal results.

3.3 INSTALLATION

- A. Install in accordance with manufacturer's current installation instructions and industry recognized best practices.
- B. Install in accordance with all code bodies having jurisdiction.

3.4 CLEANING AND PROTECTION

- A. Clean and remove all stains, grime, or other soils using soap and water. Only use detergents approved by the manufacturer for use on the finishes specified. Do not use acid solutions, steel wool, and other harsh abrasives.
- B. Damaged products must be repaired or replaced prior to substantial completion.
- C. Protect installed products until completion of work specified in this section.

3.5 FIELD QUALITY CONTROL

- A. Field Test: Follow manufacturer's cycle test procedures.
 - 1. Notify Owner's Representative, local Fire Marshal, alarm sub-contractor and elevator sub-contractor or service company minimum one week in advance of scheduled testing.
 - 2. Complete maintenance service record.

3.6 DEMONSTRATION

- A. Demonstrate required testing and maintenance procedures to Owner's Representative.

3.7 MAINTENANCE AND TESTING

- A. Perform minimum semi-annual maintenance and testing on each smoke containment system as required by the manufacturer's warranty, code agency evaluation reports, and as required by local authority having jurisdiction.
 - 1. Retain permanent record of tests.
- B. Future Painting: Paint elevator door frame and/or auxiliary rails in accordance with Operation and Maintenance Manual.
- C. Fire Event: Owner shall engage a qualified inspector to assess unit(s) after exposure to a fire event.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Aluminum storefront system.
- B. Operable Windows.
- C. Accessories.

1.2 REFERENCES

- A. Unless otherwise noted, standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes as of the date of issue of this Project Manual.
- B. Referenced Standards:
 - 1. AA – Designation System for Aluminum Finishes.
 - 2. AAMA –Metal Curtain Wall, Window, Store Front and Entrance – Guide Specifications Manual, Current Edition.
 - 3. AAMA 611–Voluntary Standards for Anodized Architectural Aluminum.
 - 4. AAMA SFM-1– Aluminum Storefront and Entrance Manual.
 - 5. ANSI A117.1 – Standard for Accessible and Usable Buildings and Facilities.
 - 6. ASTM A36/A36M –Standard Specification for Carbon Structural Steel.
 - 7. ASTM B209/B209M–Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - 8. ASTM B221/B221M–Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
 - 9. ASTM E283 –Standard Test Method for Determining Rate of Air Leakage through Exterior Windows, Curtain Walls, and Doors under Specified Pressure Differences across the Specimen.
 - 10. NFRC 100 –Procedure for Determining Fenestration Product U-Factors.
 - 11. NFRC 200 –Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence.
 - 12. NFRC 400 – Procedure for Determining Fenestration Product Air Leakage.

1.3 SUBMITTALS

- A. Shop Drawings: Indicate system dimensions, framed opening requirements and tolerances, affected related Work, expansion and contraction joint location and details.
- B. Product Data: Provide component dimensions, describe components within assembly, anchorage and fasteners and glass.
- C. Submit two samples, 12" x 12" minimum in size, illustrating pre-finished aluminum surface, EPDM or neoprene gasketing and glass and glazing materials.
- D. Provide windload and deadload charts to verify that the system meets all design loads and meets the minimum PSF required at the location of the project.

1.4 SYSTEM DESCRIPTION

- A. Aluminum storefront system includes shop fabricated, factory pre-finished tubular aluminum sections and doors, glass, related flashings, anchorage and attachment devices.

1.5 PERFORMANCE REQUIREMENTS

- A. Air leakage of window system shall not exceed 0.3 cubic feet per minute per square foot of window area at a pressure differential of 1.57 pounds per square foot when tested according to NFRC 400 or ASTM E283.
- B. Air leakage of each single entrance door shall not exceed 0.3 cubic feet per minute per square foot of door area at a pressure differential of 1.57 pounds per square foot when tested according to NFRC 400 or ASTM E283.
- C. Air leakage of each set of double entrance doors shall not exceed 1.0 cubic feet per minute per square foot of door area at a pressure differential of 1.57 pounds per square foot when tested according to NFRC 400 or ASTM E283.

1.6 REGULATORY REQUIREMENTS

- A. Window systems and exterior doors shall be certified under provisions of the California Energy Code.

1.7 QUALITY ASSURANCE

- A. Perform Work in accordance with AAMA SFM-1.
- B. Conform to requirements of ANSI A117.1.
- C. These requirements establish standards of design and quality for material, construction and workmanship. When substitute products of equal quality are to be submitted, contractor shall submit for consideration supporting technical literature, samples, drawings and performance data so these items may be evaluated.
- D. The approved manufacturer's recommended installation procedures will become the basis for inspecting or rejecting actual installation procedures used on the work.

1.8 QUALIFICATIONS

- A. Manufacturer and Installer: Company specializing in manufacturing aluminum glazing systems.

1.9 DELIVERY, STORAGE AND HANDLING

- A. Protect pre-finished aluminum surfaces with strippable coating. Do not use adhesive papers or sprayed coatings that bond when exposed to sunlight or weather.

1.10 WARRANTIES

- A. Storefront System:
 - 1. Provide written warranty in form acceptable to Owner jointly signed by manufacturer, installer and Contractor warranting work to be watertight, free from defective materials, defective workmanship, glass breakage due to defective design, and agreeing to replace components which fail within one year from date of Project Completion.
 - 2. Warranty shall cover following:
 - a. Complete watertight and airtight system installation within specified tolerances.
 - b. System is structurally sound and free from distortion.
- B. Finish: Finished coating system specified in this Section, as applied over aluminum

extrusions, shall be warranted for a period of ten years from date of Project Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design: Oldcastle Building Envelope, Product: Series 3000XT thermally broken storefront, center loaded, with Series 375 doors.
- B. Kawneer Company, Inc.
- C. United States Aluminum.
- D. Arcadia
- E. Or accepted equal.

2.2 MATERIALS

- A. Extruded Aluminum: ASTM B221; 6063 alloy, T5 temper. Wall thickness shall provide structural strength to meet specified performance requirements.
- B. Sheet Aluminum: ASTM B209.
- C. Fasteners: Stainless steel.
- D. Perimeter Anchors: Stainless steel, or plated steel providing the steel is properly isolated from the aluminum.

2.3 DOORS

- A. Doors: Medium stile door. Vertical stile and top rail systems on all door frame systems shall be 4-1/4" wide, and bottom rail shall be 10" high. Corner construction shall consist of mechanical clip fastening, SIGMA deep penetration and minimum 1-1/8" long fillet welds. Glazing stops shall be snap-in type with EPDM flashing gaskets.
 - 1. Hardware: Hardware shall be installed at the factory prior to shipment.
 - 2. Thresholds: Thresholds shall be one piece thresholds in a new bed of non-shrink grout. Threshold shall set no higher than 1/2" from the lowest floor surface. When complete, threshold shall be accessible.
- B. Weather-strip: Door manufacturer's standard felt insert strip designed into door system along perimeter door edges.

2.4 OPERABLE WINDOWS

- A. Basis of Design: Oldcastle Signature series 3 1/4" lap.
- B. Design: Overlay with perimeter frame.
- C. Thermal Barrier: Crimped in place glass reinforced polyamide 6/6 nylon strut.
- D. Hardware: Corrosion resistant and compatible with aluminum. Fasteners: stainless steel screens, epoxy adhesives, or other materials warranted by manufacturers.

- E. Operation Type: Casement.
- F. Electric Operation Actuator: Operators at each operable panel, connected to security electronics system. Supermaster 24V chain actuator or accepted equal.

2.5 ACCESSORIES

- A. Flashings and Closures: 0.050" thick aluminum, finish as selected to match mullion sections where exposed.

2.6 GLASS AND GLAZING MATERIALS

- A. Glass and Glazing Materials: As specified in Section 08 81 00 "Glass Glazing".
- B. Glazing gaskets and seals used for aluminum work shall be an integrated glazing system designed by the aluminum work manufacturer to produce a watertight assembly, and shall be physically and chemically compatible with each other and with adjacent materials.
 - 1. Neoprene and EPDM materials shall not come in contact with silicone sealant materials.
 - 2. Gaskets shall be designed, when in final compression form, to be compressed a minimum of 25% and a maximum of 40%, and to exert a pressure of between 4 lbs. and 10 lbs. pressure per linear inch.
 - 3. All side light and transom glass shall be set with the same type and size of glazing gasket material.
- C. Contractor shall provide and set lead blocking for all window systems installed. Each glass panel supplied shall display a factory mark certifying each glass panel is manufactured of tempered glass. Plate glass and laminated glass will not be acceptable.

2.7 SEALANT MATERIALS

- A. Sealant and Backing Materials: As specified in Section 07 92 00 "Joint Sealants".

2.8 FABRICATION

- A. Fabricate components with minimum clearances and shim spacing around perimeter of assembly, yet enabling installation and dynamic movement of perimeter seal.
- B. Accurately fit and secure joints and corners. Make joints flush, hairline, and weatherproof. Sealant will not be allowed at exposed joints.
- C. Prepare components to receive anchor devices. Fabricate anchors.
- D. Arrange fasteners and attachments to conceal from view.
- E. Prepare components with internal reinforcement of 1/4 inch thick galvanized steel mounting backing plates for door hardware and hinge hardware as per ASTM A36.
- F. Exposed work shall be carefully matched to produce continuity of line, design and finish. Joints in exposed work, unless otherwise shown or required for thermal movement, shall be accurately fitted, rigidly secured with hairline contacts and sealed watertight.
- G. Removable members such as glass stops shall be extruded and securely engaged into adjacent components as indicated by product manufacturer.
- H. Face clearances between glass and stop shall comply with code requirements and glass

manufacturer's recommendations.

- I. All fasteners shall be of sufficient strength to support both horizontal wind load and vertical dead load, with a Factor of Safety of 1.5. They shall be spaced and be sized to develop the maximum strength of the members they secure or support. Washers, where required, shall be of the same material as the fastener. Unless otherwise shown or approved, fastening systems shall be concealed.
- J. Sealants, gaskets, setting blacks, tapes and separators, where used, shall be physically and chemically compatible with each other and with adjacent materials. Items shall be installed so that they will not become dislodged during or after assembly of units.

2.9 SPECIAL REQUIREMENTS

- A. Dissimilar Materials Protection: Use chromate gasketing to separate aluminum surfaces in contact with other metals, plaster or concrete, or heavy coat of alkali resistant bituminous paint. Aluminum need not be separated from stainless or galvanized steel.

2.10 FINISHES

- A. All aluminum extrusions shall have Anodized finish, to be selected from manufacturer's full range of standard colors.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify dimensions, tolerances and method of attachment with other work.
- B. Verify wall openings and adjoining air and vapor seal materials are ready to receive work of this Section.

3.2 INSTALLATION

- A. Install window wall system in accordance with manufacturer's instructions and AAMA – Metal Curtain Wall, Window, Storefront and Entrance – Guide Specifications Manual. Manufacturer shall provide installation instructions and installer shall comply with these instructions.
- B. Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances, aligning with adjacent work.
- C. Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.
- D. Provide alignment attachments and shims to permanently fasten system to building structure.
- E. Frames shall be anchored to structure with concealed fasteners appropriate for use with type of adjacent construction. Fasteners shall securely fasten frames to wall construction involved. Fasteners shall provide stiffness and rigidity to keep frames square, in accurate position without twisting, buckling or warping. Fasteners to framing substrate shall be the following minimums; greater as required by the window wall manufacturer or as conditions warrant:
 - 1. Concrete/Masonry: Hilti KB3 wedge anchors or accepted equal at 12" on center.

- F. Install flashings and sealant.
- G. Set thresholds in bed of mastic and secure.
- H. Separate dissimilar materials at contact points, including metal in contact with masonry surfaces, with bituminous paint in conformance with ASTM D1187 or preformed separators to prevent contact or corrosion.

3.3 TOLERANCES

- A. Maximum Variation from Plumb: 0.06" every 3' non-cumulative or 0.06" per 10', whichever is less.
- B. Maximum Misalignment of Two Adjoining Members Abutting in Plane: 1/32".

3.4 CLEARANCES

- A. Top and sides of door shall have a minimum of 1/16" to a maximum of 1/8" clearance.
- B. Bottom of door and threshold shall have a minimum of 1/8" to a maximum of 1/4" clearance.
- C. All doorframes shall be measured with the minimum clearance of exact size or a maximum of 1/4" overall clearance to fit sides of opening to 1/8" at top of opening.
- D. All installation clearances for door frame and door in either newly constructed openings or as replacement units for existing openings will be strictly adhered to. No other minimum or maximum clearances will be acceptable and will prove cause for total replacement of the opening at the sole expense to the Contractor.
- E. Mortise hardware shall fit flush with finished trim moldings and applied directly to recessed sidewalls of the door and or frame system. Cutouts in door or frame moldings shall require separate screw applied tabs or straps on which to mount concealed hardware per manufacturer's templates as detailed on the drawings. Where shims and spaces are required for finished appearance, they shall provide full and solid bearing for the hardware.

3.5 ADJUSTING

- A. Adjust operating hardware for smooth operation.

3.6 CLEANING

- A. Remove protective material from pre-finished aluminum surfaces.
- B. Wash down surfaces with a solution of mild detergent in warm water, applied with soft, clean wiping cloths. Take care to remove dirt from corners. Wipe surfaces clean.
- C. Remove excess sealant by method acceptable to sealant manufacturer.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Stainless steel exchange windows with fixed glazing, shelves, and speak-throughs.

1.2 REFERENCES

- A. AAMA 605.2 – Specification for High Performance Organic Coatings on Architectural Extrusions and Panels.
- B. ASTM A666 – Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
- C. ASTM B221 – Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.

1.3 SUBMITTALS

- A. Shop Drawings: Indicate opening dimensions, framed opening tolerances, affected related work and installation requirements.
- B. Product Data: Provide component dimensions, anchorage, fasteners and glass.
- C. Submit two samples 6 inch by 6 inch size illustrating window frame section, mullion section, pre-finished aluminum surfaces and glazing materials.
- D. Manufacturer's Certificate: Certify that Products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

- A. Perform Work in accordance with AAMA 101.

1.5 QUALIFICATIONS

- A. Manufacturer and Installer: Company specializing in manufacturing institutional transaction windows with sufficient documented experience.

1.6 PRE-INSTALLATION CONFERENCE

- A. Convene one week prior to commencing work of this Section.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Protect finished surfaces with strippable coating. Do not use adhesive papers or sprayed coatings that bond when exposed to sunlight or weather.

1.8 JOB AND ENVIRONMENTAL CONDITIONS

- A. Do not install sealants when ambient temperature is less than 40 degrees F.
- B. Maintain this minimum temperature during and after installation of sealants.

1.9 FIELD MEASUREMENTS

- A. Verify that field measurements are as indicated on shop drawings.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. C.R. Laurence Co., Products:
 - 1. At Non-Contact Visitation: Series S1VEA Standard Inset Aluminum Frame with Series SSSC 18 inch wide stainless steel shelf without deal tray (center shelf in frame) and Model No. N666, 6 inch round stainless steel speak-thru device.
- B. Or accepted equal.

2.2 MATERIALS

- A. Extruded Aluminum: ASTM B221; 6063 Alloy, T5 Temper.
- B. Stainless Steel. ASTM A666; Type 304.
- C. Fasteners: Stainless steel screws.

2.3 GLASS AND GLAZING MATERIALS

- A. Glass and Glazing Materials: Level 1 protection, 1-3/16" thick laminated clear glass, factory installed.

2.4 FABRICATION

- A. Fabricate components with minimum clearances and shim spacing around perimeter of assembly, yet enabling installation and dynamic movement of perimeter seal.
- B. Accurately fit and secure joints and corners. Make joints flush, hairline and weatherproof.
- C. Prepare components to receive anchor devices. Fabricate anchors.
- D. Arrange fasteners and attachments to ensure concealment from view.

2.5 FINISHES

- A. Aluminum: Standard factory satin anodized aluminum.
- B. Stainless Steel: Brushed stainless steel with No. 4 finish.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify site opening conditions under provisions of Section 01 30 00 "Administrative Requirements".
- B. Verify wall openings and adjoining air and vapor seal materials are ready to receive work of this Section.

3.2 INSTALLATION

- A. Install exchange window frames, shelving, and glazing in accordance with manufacturer's instructions.
- B. Attach window frame and shims to perimeter opening to accommodate construction tolerances and other irregularities.
- C. Align shelf and window plumb and level, free of warp or twist. Maintain dimensional tolerances, aligning with adjacent work.
- D. Install speak-throughs.
- E. Install security sealant to method required to achieve installation criteria.

3.3 TOLERANCES

- A. Maximum Variation from Level or Plumb: 0.06" every 3' non-cumulative or 0.5" per 100', whichever is less.

3.4 CLEANING

- A. Wash down surfaces with a solution of mild detergent in warm water, applied with soft, clean wiping cloths. Take care to remove dirt from corners. Wipe surfaces clean.
- B. Remove excess sealant by moderate use of methods and products acceptable to sealant manufacturer.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Detention fixed, stainless steel exterior window frames.

1.2 REFERENCES

- A. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- B. Referenced Standards:
 - 1. ANSI / NAAMM HMMA 866-01 -Guide Specifications for Stainless Steel Hollow Metal Doors and Frames.
 - 2. ASTM A666 -Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate and Flat Bar.
 - 3. ASTM C143 / C143M-Standard Test Method for Slump of Hydraulic Cement Concrete.
 - 4. ASTM E283 -Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
 - 5. ASTM E330 -Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.
 - 6. ASTM E331 -Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference.
 - 7. ASTM E547 -Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Cyclic Static Air Pressure Difference.
 - 8. ASTM F1592 -Standard Test Methods for Detention Hollow Metal Vision Systems.
 - 9. NAAMM HMMA-820 TN01-03 -Grouting Hollow Metal Frames.

1.3 SUBMITTALS

- A. Submittal Drawings:
 - 1. Show door and window elevations and sections.
 - 2. Show listing of opening descriptions including locations, material thicknesses, and anchors.
 - 3. Show location and details of all openings.
 - 4. Indicate performance grade levels on the submittal as they are shown on the contract documents.
- B. Samples:
 - 1. Window: 12 inch x 12 inch corner section showing welding of head to jamb. Glazing stop shall be applied in both head and jamb section to show their intersection.
 - 2. All samples submitted shall be of the production type and shall represent in all respects the minimum quality of work to be furnished by the manufacturer. No work represented by the samples shall be fabricated until the samples are approved, and any degradation of fabrication quality compared to the samples is cause for rejection of the work.
- C. Test Report:
 - 1. Manufacturer shall submit an independent testing laboratory report certifying that detention fixed exterior window assemblies meet the performance requirements of this Section and are constructed in accordance with the requirements of this Section. Test reports shall comply with the reporting requirements outlined in ASTM F1592.
 - 2. The manufacturer shall not proceed with fabrication without receipt of approved submittal drawings.

- a. The approved submittal drawings are the versions that have been provided to the frame manufacturer at the time of release for fabrication.

- D. Qualifications:
 1. Manufacturer shall submit their qualifications as required by this Section.

1.4 TESTING AND PERFORMANCE CRITERIA

- A. Detention Window Vision System Impact Test In Accordance With ASTM F1592.
 1. A multi-light detention fixed exterior window assembly with overall dimensions of 50 inches in width x 50 inches in height shall be constructed in accordance with this Section, and shall be impact tested in accordance with ASTM F1592, Section 7.2, Table 1, Figure 2, Grade #1 and Grade #2 as specified herein. The test assembly reports shall meet the acceptance criteria in this Section.
- B. Air Infiltration Test in accordance with ASTM E283:
 1. A multi-light detention fixed exterior window assembly with overall dimensions of 48 inches in width x 48 inches in height shall be constructed in accordance with this Section, and shall be air infiltration tested and shall allow no more than 0.06 CFM/ft² air leakage at a test pressure of 1.57 PSF.
- C. Structural Performance in accordance with ASTM E330:
 1. Uniform Load Deflection Test: The same assembly tested for air infiltration (paragraph B) shall be additionally tested for uniform Load Deflection first to the exterior (positive) side of the window, then to the interior (negative) side. No member shall deflect more than 1/175 of its span at 30 psf (STP) uniform static air pressure difference between opposite sides of the window.
 2. Uniform Load Structural Test: The same assembly tested for air infiltration (paragraph B) shall be additionally tested for uniform Load Structural at 45 psf (STP) uniform static air pressure difference between opposite sides of the window:
 - a. No glass breakage or permanent damage to fasteners, hardware parts, support arms, actuating mechanisms, or other damage which would cause the window unit to be inoperable.
 - b. Permanent deformation of individual frame or vent members shall not exceed 0.2 percent of its span.
- D. Water Resistance Test in accordance with ASTM E331 and ASTM E547.
 1. The same assembly tested for air infiltration (paragraph B) shall be additionally tested for water resistance and shall allow no water to penetrate for 15 minutes when the window is subject to a rate flow of 5.0 U.S. gal/ft²-h with a differential pressure across the window unit of 2.86 PSF.

1.5 QUALITY ASSURANCE

- A. Manufacturer's Qualification:
 1. Manufacturers shall provide evidence of having personnel and plant equipment capable of fabricating detention fixed exterior window assemblies of the type specified herein.
 2. Manufacturer shall provide evidence of a current and active written quality system, or ISO 9000 certification. Quality system documents shall provide evidence of periodic review and revision. Manufacturer shall provide certified test data and production samples as requested. Production material shall be of same design and construction as provided samples.
- B. Quality Criteria:
 1. All detention fixed exterior window construction shall meet the requirements of this Section. Fabricate assemblies in strict accordance with approved submittal drawings.

2. Fabrication methods and product quality shall meet standards set by the Detention Equipment Manufacturers Association (DEMA), a Division of the National Association of Architectural Metal Manufacturers (NAAMM), as set forth in these specifications.

PART 2 PRODUCTS

2.1 DETENTION FIXED EXTERIOR WINDOWS

- A. Manufacturers:
 1. Trussbilt – Vadnais Heights, MN
 2. Habersham Metal Products – Atlanta, GA
 3. Or accepted equal.
- B. Materials:
 1. Exterior window sections shall be 0.093 inch minimum thickness. Window sections and components shall be stainless steel conforming to ASTM A666, Type 316. Finishes for stainless steel detention fixed exterior windows shall comply with ANSI/NAAMM HMMA 866. Finish shall be #6, soft satin finish per NAAMM HMMA 802, Table 2.
- C. Construction:
 1. All windows shall have integral stops and be welded units of the sizes and types shown on approved submittal drawings. Windows shall be constructed in accordance with these specifications and shall meet performance criteria specified in this Section.
 2. Finished work shall be neat in appearance, square, and free of defects, warps and buckles. Members shall be straight and of uniform profile throughout their lengths.
 3. Jamb, header, mullion, and sill profiles shall be in accordance with the window schedule, detailed drawings, and as shown on the approved submittal drawings.
 4. Corner joints shall have all contact edges closed tight with faces mitered and stops either butted or mitered. Corner joints shall be continuously welded. The use of gussets or splice plates is not acceptable.
 - a. For detailed information on continuously welded corner joints, see Tech Note HMMA-820 TN02-03.
 5. All other face joints shall be continuously welded and finished smooth.
 6. Height of stops on security glazing or panel openings shall be as shown on approved submittal drawings. Stop height shall be sufficient to provide a minimum of 1 inch of glazing engagement.
 7. When shipping limitations or site access so dictate, or when advised by the contractor responsible for installation, windows for large openings shall be fabricated in sections designated for assembly in the field by others. Alignment plates or angles shall be installed at each joint. Such components shall be the same material and thickness as the window. Field joints shall be made in accordance with approved submittal drawings, and shall be field welded by others.
 8. Windows for multiple openings shall have mullion members which, after fabrication, are closed tubular shapes conforming to profiles shown on approved submittal drawings, and having no exposed visible seams or joints. All joints between faces of abutted members shall be continuously welded and finished smooth. All joints between stops of abutted members shall be welded along the soffit and shall be left neat and uniform in appearance. The contractor responsible for installation shall provide for welding and finishing all field joints between faces of abutted members.
 9. Jamb Anchors:
 - a. Anchor Spacing - The number of anchors provided on each jamb shall be as follows:
 - 1) Windows: 2 anchors plus 1 for each 18 inches or fraction thereof over 36 inches, spaced at 18 inches maximum between anchors.
 - b. Masonry Anchors:
 - 1) Windows for installation in masonry walls shall be provided with 3/8 inch

diameter ASTM A615 grade 40 deformed rebar anchor loops welded to the 10 gage stainless steel plates; or stainless steel straps welded to embedded stainless steel anchor plates or angles.

10. Grout guards shall be provided at all glazing stop screws on windows to be set in masonry openings. Grout guards shall be sufficient to protect preparations from grout of a 4 inch maximum slump consistency which is hand troweled in place. If pump grout that exhibits slump values of higher than 4 inches is used, additional precautions shall be taken in the field by the contractor to seal grout guards to prevent leakage and to brace window sections to prevent deformation. (Ref. HMMA-820 TN01-03, "Grouting of Hollow Metal Windows").
 - a. Grout guards for glazing stop screws shall be stainless steel and shall be factory installed and shall cover the exposed portion of the screws inside the frame throat, around the perimeter. Where mullions are required to be grouted, screws inside mullions shall be protected with grout guards.
 - b. For detailed information on grouting of metal frames, refer to Tech Note HMMA-820 TN01-03.
 - c. Where the solid grouting of frames is required, provide top openings and jamb to mullion openings to facilitate the solid grouting of frames.
11. Removable glazing stops:
 - a. In openings where security glazing is specified and where shown on the approved submittal drawings, pressed stainless steel angle glazing stops, not less than 0.093 inch thick, shall be provided. Angle stops shall be mitered or butted and tight fitting at the corner joints, and secured in place using 1/4 - 20 or 1/4 - 28 tamper resistant security screws spaced 2 inches maximum from each end and 6 inches on center maximum. The glazing stop system shall satisfy the performance criteria in this Section.

2.2 MANUFACTURING TOLERANCES

- A. The manufacturer of the windows is responsible for the manufacturing tolerances listed in this Section.
- B. Manufacturing tolerance shall be maintained within the following limits:
 1. Windows:
 - a. Width, measured between rabbets at the head: Nominal opening width + 1/16 inch, - 1/32 inch.
 - b. Height (total length of jamb rabbet): Nominal opening height + 1/16 inch, - 1/32 inch.
 2. Cross sectional profile dimensions:
 - a. Face: +/- 1/32 inch.
 - b. Stop: +/- 1/32 inch.
 - c. Rabbet: +/- 1/32 inch.
 - d. Depth: +/- 1/32 inch.
 - e. Throat: +/- 1/16 inch.
 3. Windows overlapping walls to have throat dimension 1/8 inch greater than wall thickness to accommodate irregularities in wall construction.
 4. Flatness of large windows: 1/8 inch in 10 feet of length or width.

2.3 FINISH

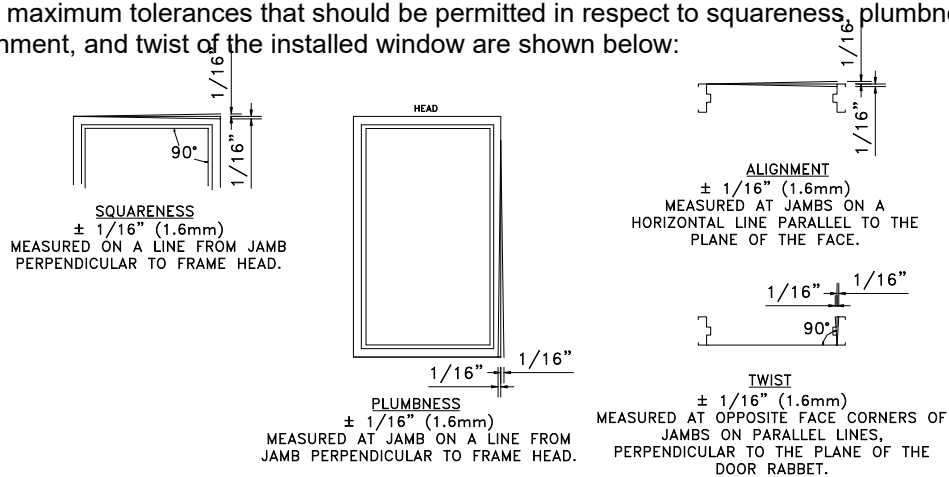
- A. After fabrication, all tool marks and surface imperfections shall be filled and sanded as required to make face sheets, vertical edges and weld joints free from irregularities. After appropriate metal preparation, all exposed surfaces of detention fixed exterior windows shall receive a #6, soft satin finish in accordance with ANSI/NAAMM/HMMA 866.

3.1 SITE STORAGE AND PROTECTION OF MATERIALS

- A. The contractor responsible for installation shall remove wraps or covers from detention fixed exterior windows upon delivery at the building site.
- B. The contractor responsible for installation shall ensure that materials are properly stored on planks or dunnage in a dry location. Detention fixed exterior windows shall be stored in a vertical position and spaced by blocking. Materials shall be covered to protect them from damage but in such a manner as to permit air circulation.

3.2 INSTALLATION

- A. The maximum tolerances that should be permitted in respect to squareness, plumbness, alignment, and twist of the installed window are shown below:



- B. Protecting the window from accidental abuse, build walls to the window while maintaining proper alignment. Check plumb and square as wall progresses.
- C. Window members shall be fully grouted to provide added security protection against battering, wedging, and spreading of the window. Grout guards for glazing stop screws are intended to protect exposed removable screws from masonry grout of 4 inch maximum slump consistency which is hand troweled in place. If a light consistency grout (greater than 4 inch slump in accordance with ASTM C143/C143M) is to be used, special precautions shall be taken in the field by the installation contractor to protect tapped holes in the windows.
 - 1. Large window sections are not intended or designed to act as forms for grout or concrete. Grouting of large metal sections shall be done in "lifts" or precautions shall be otherwise taken by the contractor to insure that windows are not deformed or damaged by the hydraulic forces that occur during this process. Refer to NAAMM's HMMA TechNotes HMMA-820 TN01-03, "Grouting Hollow Metal Frames."
- D. Completely mask frames with waterproof material during installation of adjacent masonry and grouting to protect the finish.
- E. Any grout or other bonding material shall be cleaned off of windows immediately following installation. Exposed window surfaces shall be kept free of grout, tar, or other bonding material or sealer.
- F. Install glazing materials in accordance with manufacturers' installation instructions.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Tubular Skylights
- B. Integral Counter-Flashing.

1.2 REFERENCES

- A. Unless otherwise noted, standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes as of the date of issue of this Project Manual.
- B. Reference Standards:
 - 1. ASTM A463/A463M – Standard Specification for Steel Sheet, Aluminum Coated, by the Hot Dip Process.
 - 2. ASTM A653/A653M – Standard Specification for Steel Sheet, Zinc Coated (Galvanized), by the Hot Dip Process.
 - 3. ASTM D635 – Standard Test Method for Rate of Burning and/or Extent of Time of Burning of Self-supporting Plastics in a Horizontal Position.
 - 4. ASTM D1929 – Standard Test Method for Ignition Properties of Plastics.
 - 5. ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials.
 - 6. ASTM E283 – Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
 - 7. ASTM E308 – Standard Practice for Computing the Colors of Objects by Using the CIE System.
 - 8. ASTM E330 – Structural Performance of Exterior Windows, Curtain Walls and Doors.
 - 9. ASTM E547 – Test Method for Water Penetration of Exterior Windows, Skylights, Doors and Curtain Walls by Cyclic Air Pressure Difference.
 - 10. ICC AC-16 – Acceptance Criteria for Plastic Skylights.
 - 11. FS TT-C-494B – Coating Compound, Bituminous, Solvent Type, Acid Resistant.
 - 12. UL 181 – Factory Made Air Ducts and Air Connectors
 - 13. UL 790 – Standard for Tests for Fire Resistance of Roof Covering Materials.
 - 14. ASTM E 108-07a –Standard Test Methods for Fire Tests of Roof Coverings.

1.3 SUBMITTALS

- A. Submit shop drawings and product data.
 - 1. Provide configurations, dimensions, locations, fastening methods, wiring diagrams, and installation details.
 - 2. Include characteristics of light admitted, transparency and insulating value of unit.
 - 3. Manufacturer's installation instructions.
 - 4. Provide samples of product as requested by the Architect.

1.4 PERFORMANCE REQUIREMENTS

- A. Completed tubular skylight assemblies shall be capable of meeting the following performance requirements:
 - 1. Air Infiltration Test: Air infiltration shall not exceed 0.30 cfm/sf aperture with a pressure delta of 1.57 psf across the tube when tested in accordance with ASTM E283.
 - 2. Water Resistance Test: No uncontrolled water leakage at 10.5 psf pressure differential with water rate of 5 gallons/hour/sf when tested in accordance with ASTM E547.
 - 3. Uniform Load Test:
 - a. No breakage, permanent damage to fasteners, hardware parts, or damage to make tubular skylight system inoperable or cause excessive permanent deflection of any section when tested at a positive load of 150 psf or negative load of 70 psf.
 - b. All units shall be tested with a safety factor of three for positive pressure and two for negative pressure, acting normal to plane of roof in accordance with ASTM E330.
 - 4. Flammability:
 - a. When used with the Dome Edge Protection Band, all domes shall meet fire rating requirements as described in the 2007 CBC.
 - b. Self-ignition Temperature – Greater than 650°F per ASTM D1929.
 - c. Smoke Density – Rating no greater than 450 per ASTM E84 in way intended for use, Classification C.
 - d. Rate of Burn and/or Extent – Maximum Burning Rate: 2.5 inches/min. per ASTM D635, Classification CC-2.
 - e. Rate of Burn and/or Extent – Maximum burn Extent: 1 inch per ASTM D635, Classification CC-1.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications. Factory authorized installer.
- B. Manufacturer Qualifications: Engaged in manufacture of tubular skylights for minimum 15 years.

1.6 SEQUENCING AND SCHEDULING

- A. Coordinate work of this Section with the work of other trades.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.

1.8 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.9 WARRANTY

- A. Tubular Skylight Assembly: Manufacturer's standard 10-year warranty.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design: Solatube International, Inc., Products:
1. SolaMaster Series 21 inch Solatube Model 750 DS Closed Ceiling.
 2. Velux
 3. Or accepted equal.

2.2 TUBULAR SKYLIGHT ASSEMBLIES

- A. General: Transparent roof-mounted skylight dome and self-flashing curb, reflective tube, and ceiling level diffuser assembly, transferring sunlight to interior spaces; complying with ICC AC-16.
1. Roof Dome Assembly: Transparent, UV and impact resistant dome with flashing base supporting dome and top of tube.
 - a. Outer Dome Glazing: Type DI, 0.125 inch minimum thickness injection molded acrylic classified as CC2 material; UV inhibited, impact modified acrylic blend with shock inner dome.
 2. Raybender 3000: Variable prism optic molded into outer dome to capture low angle sunlight and limit high angle sunlight.
 3. Roof Flashing Base: One piece, seamless, leak-proof flashing functioning as base support for dome and top of tube.
 - a. Base Material: Sheet steel, corrosion resistant conforming to ASTM A 653/A 653M or ASTM A 463/A 463M, 0.028 inch thick.
 - 1) Base Style: Type FCM curb cap with inside dimensions of 27 inches by 27 inches to cover base curb.
 - 2) Flashing Insulator: Type FI, Thermal isolation material for use under flashing.
 - 3) Dome Edge Protection Band: Type PB, for fire rated roofs. Galvanized steel. Nominal thickness of 0.039 inches.
 4. Tube Ring: Attached to top of base section; 0.090 inch nominal thickness injection molded high impact PVC to prevent thermal bridging between base flashing and tubing and channel condensed moisture out of tubing.
 5. Dome Seal: Adhesive backed weatherstrip 0.63 inch tall by 0.28 inch.
 6. Reflective Tubes: Aluminum sheet, thickness 0.018 inch.
 - a. Interior Finish: Spectralight Infinity high reflectance specular finish on exposed reflective surface. Specular reflectance for visible spectrum (400 nm to 760 nm) greater than 99 percent. Total solar spectrum reflectance (400 nm to 2500 nm) not less than 93 percent.
 - b. Color: a* and b* (defined by CIE L *a*b* color model) shall not exceed plus 2 or be less than minus 2 as determined in accordance to ASTM E308.
 - c. Top Tube Angle Adapter and Bottom Top Tube Angle Adapter Kit, Type AK; reflective 30 degree adjustable top and bottom angle adapters (one each) 16 inches long.
 - d. Extension Tubes:
 - 1) Type E08; Reflective extension tube, type EXX, Notched for Open Ceiling diffuser attachment, 24 inches long.
 - 2) Reflective 90 Degree Adjustable Tube: Provide manufacturer's standard extension tube angle adapters for applications requiring two Type A2 0 to 90 degree extension tube angle adapters.

- e. Ceiling mounted box transitioning from round tube to square ceiling assembly, supporting light transmitting surface at bottom termination of tube; 23.8 inches by 23.8 inches square frame to fit wood framed gypsum board ceilings.
 - f. Round to square transition box made of opaque polymeric material, classified as CC2, Class C, 0.110 inch thick.
 - g. Natural Effect Lens: Type NL, made of acrylic, classified as CC2, Class C, 0.060 inch thick, with open cell foam seal to minimize condensation and bug, dirt, and air-infiltration per ASTM E283.
 - h. Lens: Type L1 Optiview Fresnel lens, Classified as CC2, designed to maximize light output and diffusion with extruded aluminum frame. Visible Light Transmission shall be greater than 90 percent at 0.022 inch thick.
7. Accessories:
- a. Daylight Dimmer: Type D Electro-mechanically actuated daylight valve; for universal input voltages ranging between 90 and 277 V at 50 or 60 Hz; maximum current draw of 50 ma per unit; controlled by low voltage, series Type T02: circuited, 4 conductor, size 22 cable; providing daylight output between 2 and 100 percent. Provide with dimmer switch and cable.
 - 1) Local Dimmer Control: Provide with dimmer switch and cable.
 - 2) Switch: Type SW, Manufacturer-specific low voltage DC DP/DT switch (white) required to operate Daylight Dimmer.
 - 3) Cable: Type CA, Two conductor low voltage cable (500 ft.) for multiple unit DC connection.
 - b. LED light add-on kit.
 - c. Wire Suspension Kit: Type E, Use the wire suspension kit when additional bracing to the structure is required.

2.3 ACCESSORIES

- A. Fasteners: Same material as metals being fastened, non-magnetic steel, non-corrosive metal of type recommended by manufacturer.
- B. Suspension Wire: Steel, annealed, galvanized finish, size and type for application and ceiling system requirement.
- C. Sealant: Polyurethane or copolymer based elastomeric sealant as recommended by manufacturer.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. Immediately notify the County if substrate conditions are unsatisfactory. Do not proceed with work until unsatisfactory conditions are corrected.

3.2 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

- A. Install in accordance with manufacturer's printed instructions.

- B. After installation of first unit, field test to determine adequacy of installation. Conduct water test in presence of County, Contractor, or their designated representative. Correct unsatisfactory conditions before proceeding with installation of subsequent units.

3.4 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Final Completion.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. BHMA finish door hardware for hollow metal, wood, and aluminum doors.
- B. Accessories including but not limited to door stops, kickplates, and push/pull plates.
- C. Weatherstripping, seals, and thresholds.
- D. Auxiliary Locks (Cabinets, Drawers, and Padlocks).

1.2 PRODUCTS SUPPLIED BUT NOT INSTALLED UNDER THIS SECTION

- A. Hardware templates for doors and frames.

1.3 PRODUCTS SUPPLIED BUT NOT INSTALLED UNDER THIS SECTION

- A. Hardware templates for doors and frames.

1.4 REFERENCES

- A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only.
 - 1. Refer to Division 01 for definitions, acronyms, and abbreviations.
 - 2. Unless otherwise noted, standards, manuals, and codes refer to the latest edition as of the issue date of this Project Manual.
- B. Conform to the following Referenced Standards and Requirements:
 - 1. CBC – 2019 California Building Code.
 - 2. ADA – Americans with Disabilities Act - 2010 Standards for Accessible Design.
 - 3. NFPA 80 – Standard for Fire Doors and other Opening Protectives.
 - 4. NFPA 101 – Life Safety Code.
 - 5. ANSI A156 Series – Builders Hardware Manufacturers Association (BHMA) Standards Set.

1.5 COORDINATION:

- A. The hardware groups/sets specified in section 08 71 00 - Part 3 are intended to establish type and design standard when used together with the requirements of this Section, Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections. Examine Contract Documents and furnish proper hardware for door openings. Refer to specifications for clarification and detailed requirements and provide products and services in specifications even if not written in hardware groups/sets in section 08 71 00 - Part 3.
- B. Coordinate work of this Section with other directly affected Sections involving manufacturer of any internal reinforcement for door hardware. In particular, coordinate door preparation in accordance with applicable regulatory and trade standards specified.
 - 1. Provide hardware templates to door and frame manufacturer. Provide two templates to those manufacturers who are not currently registered template book holders.
 - 2. Provide finish hardware schedule for use by the door and frame suppliers.

3. Where hardware sets/groups have different information than the specifications, refer to the specifications and drawings for clarification and bid combined hardware sets/groups and Contract Documents/specifications. Provide combined materials/devices at time of submittals in addition to other coordination items:
 - a. Coordinate keying requirements as specified in this Section.
- C. Convene coordination meeting between all opening vendors and installers at least two weeks prior to purchasing doors, frames, door hardware, and electrical devices required for complete systems.
 1. Required attendance includes, but is not limited to, the following: Contractor, hardware supplier and/or installer, door supplier and/or installer, frame supplier and/or installer, security card reader vendor and/or installer, and electrical contractor.
 2. Contractor shall be responsible for verifying that the door hardware accepted for installation is compatible for use with the doors and door-frames.

1.6 SUBMITTALS

- A. Pre-Hardware Schedule:
 1. Report all prevailing conditions that will adversely affect satisfactory execution of work. Examine existing doors and/or frames scheduled for hardware replacement.
- B. Submit a detailed door and hardware schedule according to the following:
 1. Hardware Schedule:
 - a. Submit hard copy pages as required in Division 01 as well as via electronic PDF in vertical format as illustrated by the Sequence of Format for the Hardware Schedule as published by the Door and Hardware Institute. Schedules which do not comply will be returned for correction before checking. Horizontal-type schedules will be returned for correction before checking.
 - b. Hardware schedule shall clearly indicate each hardware group specified and manufacturer of each item proposed.
 2. Provide two copies of illustrations from manufacturer's catalogs and data in brochure form.
 3. Wiring Information: Provide manufacturers' wiring information including manufacturers' door elevation diagrams for electrified hardware based on Door Hardware Institute (DHI) core class "Electrified Architectural Hardware" DHI class #COR133. Openings where only magnetic hold-opens or door position switches are specified do not require wiring information. Provide information with hardware schedule submittal for review. Provide detailed wiring diagrams with hardware delivery to jobsite.
 4. Review of schedules does not relieve the Contractor of providing all hardware required for the Work, whether or not such hardware was inadvertently omitted from Submittal.
- C. Templates:
 1. Provide listing of manufacturer's template numbers for each item of hardware in hardware schedule.
 2. Submit templates and "Reviewed Hardware Schedule" to door and frame supplier and others as applicable to enable proper and accurate sizing and

locations of cutouts and reinforcing.

- D. Installation Instructions:
 - 1. Provide manufacturer's written installation and adjustment instructions for finish hardware.
 - 2. Send installation instructions to site with hardware.
- E. Single Manufacturers for Manufacturer's Devices.
 - 1. Obtain each type of hardware from single manufacturer, although several may be indicated as offering products complying with requirements.
- F. Contract Closeout Submittals: Include specific requirements indicated below.
 - 1. Operating and maintenance manuals: Submit three sets containing the following:
 - a. Complete information in care, maintenance, and adjustment, data on repair and replacement parts, and information on preservation of finishes.
 - b. Catalog pages for each product.
 - c. Name, address, and phone number of local representative for each manufacturer.
 - d. Parts list for each product.
 - e. Copy of final accepted hardware schedule, edited to reflect "As installed".
 - f. Copy of final keying schedule.

1.7 QUALITY ASSURANCE:

- A. Supplier Qualifications and Documentation:
 - 1. Hardware Supplier Qualifications: Firm specializing in the supply and servicing of institutional and commercial door hardware; accredited by manufacturers; and having a minimum of three years documented experience. Hardware supplier to furnish list of at least ten past, finished projects. Include date completed, project location, and references. At least one member of the firm's staff shall be a member of DHI in good standing and is a DHI certified consultant having earned the title Architectural Hardware Consultant (AHC).
- B. Manufacturer of Submitted Devices - Qualifications and Documentation:
 - 1. Manufacturer Qualifications: Manufacturer specializing in manufacturing institutional and commercial door hardware with a minimum five years with the following documented experience. Furnish list of at least ten past, finished projects. Include date completed, project location, and references. Past project contact information will determine if Builders Hardware is acceptable.
- C. Installer of Submitted Devices - Qualifications and Documentation:
 - 1. Installer qualifications: The installer of assembly shall be trained in the trade of hanging commercial doors on commercial frames with commercial hardware. Supplier and Installer of door assemblies shall be authorized representative of manufacturers and have minimum of five years successful experience in detailing, supplying, and installing door assemblies specified on projects of similar size, complexity, and type to this Project.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products in manufacturer's original containers, dry and undamaged, with seals

and labels intact.

- B. Storage: Store materials in a cool and dry location, elevated from the ground and protected from the elements, and secured from theft or pilferage.

1.9 WARRANTY

- A. Warranty installed units to be free from defects in material and workmanship as follows:
 - 1. Hinges: Lifetime Warranty (Life of Building).
 - 2. Locksets and Exit Devices: Three years.
 - 3. Closers: Ten years.
 - 4. All other hardware: Two years.

1.10 MAINTENANCE

- A. Provide special wrenches and tools applicable to each special hardware component.
- B. Provide maintenance tools and accessories supplied by hardware manufacturer.

PART 2 - PRODUCTS

2.1 FINISH

- A. Where hardware groups/sets have different information, refer to the following for clarification. Provide hardware groups/sets devices/finishes, along with added finishes below, as indicated on drawings and detailed requirements for each type of device:
 - 1. Typical BHMA finish designation references:
 - a. BHMA 626 – Satin chromium plated brass or bronze.
 - b. BHMA 628 – Satin or dull aluminum, clear anodized (uncoated).
 - c. BHMA 630 – Satin stainless steel.
 - d. BHMA 652 – Satin chromium plated steel.
 - 2. Closers and Magnetic Holders (electrified, hold-open device):
 - a. BHMA 689 – Sprayed aluminum paint finish.

2.2 HARDWARE TEMPLATE

- A. Make templates for hardware to be applied to metal doors or pre-finished doors.
- B. Hinge templates shall conform to ANSI A156.7.
- C. Promptly furnish template information or templates to door and frame manufacturers.
- D. Coordinate hardware items to prevent interference with each other.

2.3 FIRE RATED DOORS AND EXIT DOORS

- A. Where hardware groups/sets have different information, refer to the following for clarification. Provide hardware groups/sets devices along with added devices as indicated on drawings and detailed requirements for each type of device. Provide all specifications even if not written in hardware sets/groups.

- B. Provide all hardware necessary to meet the requirements of CBC for fire doors and exit doors, as well as to other requirements specified, even if such hardware is not specifically mentioned under Article "Hardware Schedule" of this Section.

2.4 SCREWS, BOLTS, AND FASTENING DEVICES

- A. Exposed head oval phillips type screws in countersunk holes unless otherwise specified. Use screws, bolts, washers, grommets, nuts, and other fastening devices of appropriate length, type, head, metal, and finish as necessary for proper match and application of hardware.
- B. Threshold anchors shall be Flat Sleeve Anchors (FHSL 25 1/4 - 20 2 inch) cadmium plated expansion anchor screw in one unit.

2.5 SUBSTITUTIONS

- A. Products referenced by specific brand names and model numbers have been identified by Owner to match other products in use either completed or in the course of completion. No substitutions permitted per Public Contract Code Section 3400.
 - 1. Otherwise refer to Division 01 for substitutions.

2.6 HANGING HARDWARE

- A. Butt Hinges:
 - 1. Acceptable Manufacturers:
 - a. McKinney Products Co.
 - b. Hager Manufacturing.
 - c. Bommer Manufacturing.
 - 2. Where hardware groups/sets have different information (number of hinges and sizing), refer to the following for clarification. Provide hardware groups/sets devices along with added devices as indicated on Drawings and detailed requirements for each type of device.
 - a. Butt hinges shall be manufactured in accordance with ANSI/BHMA A156.1.
 - b. Provide wide throw hinges where required:
 - 1) Submit and provide hinge widths sufficient to clear trim projection when door swings 180 degrees. All doors shall swing 180 degrees if wall allows.
 - 2) Utilize wide throw type hinges to clear frame or wall obstructions/cladding in order for doors to completely open. See 180 degree language above.
 - 3) Where a door closer device is specified and will be installed on pull side/hinged side of doors (i.e. closers will hit walls or other surfaces when door is completely open), provide wide throw type hinges to give sufficient pocket depth to hide closer behind door. Do not pinch or crush closer between the door and wall surface.
 - 4) Confirm hinge sizing with frame and wall details.
 - c. Provide "weight/strength" as specified in hardware groups/sets in Part 3 (hinge nomenclature basis-of-design weight/strength).
 - d. For doors 1-3/4 inches thick and up to 36 inches wide, provide hinge height of 4-1/2 inches.

- e. For doors 1-3/4 inches thick and 37 inches to 48 inches wide, provide heavy duty, four ball bearing hinges and height of 5 inches.
- f. If hardware sets specify height (example: 5 inches tall at 36 inch wide door), provide height as specified for project standards at these locations.
- g. Provide two butts for doors up to 60 inches high and one additional butt for each 30 inches of height or fraction thereof.
- h. Provide non-removable pins at exterior doors.
- i. Provide ball-bearing hinges. Non-ball-bearing hinges are not acceptable.
- j. Electric Hinges: Provide electrified hinges with certified UL Listed, concealed wires. Provide electric hinges with standardized wire colors to accommodate up to 12 wires (4, 6, 8 or 12 as required per to provide sufficient number of concealed wires to accommodate electric function of specified hardware). If additional wires are specified (more than needed for electrified devices), provide the wires specified.

2.7 SECURING DEVICES (LATCHING SYSTEMS)

- A. Mortise Locksets, Latchsets, and Deadbolts:
 - 1. Acceptable Manufacturers:
 - a. Schlage Lock Co. LV9000 Series.
 - b. No substitutions.
 - 2. Levers:
 - a. Provide levers to return to door within 1/2 inch.
 - b. Provide exterior side lever trim with vandal resistant feature (heavy duty lever trim designed to withstand abuse and vandalism):
 - 1) Schlage L9000 series Vandlgard™. Vandlgard example nomenclature: Storeroom Lockset LV9080 (added "V" nomenclature after the "L" nomenclature for lockset to have increased strength against abuse or vandalism) Locked lever freely rotates up and down while remaining securely locked. Provide seven-year warranty.
 - 3. Where hardware groups/sets have different information, refer to the following for clarification. Provide hardware groups/sets devices along with added devices as indicated on Drawings and detailed requirements for each type of device:
 - a. Locksets shall meet the requirements of ANSI/BHMA A156.13-1994, Operational Grade 1.
 - b. Provide only thumbturn devices that meet accessibility requirements. Example: Schlage L583-363 devices. No center pivoting thumbturns allowed.
 - c. If deadbolts or lockbolts are utilized on the project, devices shall be interconnected with the latching mechanism on all egress doors to provide single movement function to unlatch doors.
 - d. Backset: 2-3/4 inches. Provide minimum 1 inch throw stainless steel deadbolt Provide minimum 3/4 inch throw for latch bolt.
 - e. Strikes:
 - 1) Provide ANSI 4-7/8 inch standard strike.
 - 2) Provide curved lip-type strike at all locations if possible, to prevent

catching clothing or other objects on strike. Where required, provide detail and flat strike.

- 3) Where required, provide extended lip strike so that the lock or latchset latch will not come in contact with frame or added trim on or adjacent to the frame. Example: Don Jo device #MEST-104, but provide submitted manufacturer equivalent extended lip strike.

B. Exit Devices:

1. Acceptable Manufacturers:
 - a. Von Duprin.
 - b. No substitutions.
2. Where hardware groups/sets have different information, refer to the following for clarification. Provide hardware groups/sets devices along with added devices as indicated on Drawings and detailed requirements for each type of device:
 - a. Provide specified 9949, concealed vertical cable system in the exit/panic devices, no substitution.
 - b. All exit devices shall be UL listed for panic. Exit devices for labeled doors shall be UL listed as "Fire Exit Hardware".
 - c. Provide cylinders for exit devices with locking trim and cylinder dogging. Provide cylinder dogging feature for non-rated exit devices.
3. The unlatching force of panic hardware shall not exceed 5 pounds, applied in the direction of travel, certified by UL to meet requirements of CBC Section 11B-309.4.

C. Flush Bolts and Dust Proof Strikes:

1. Acceptable Manufacturers:
 - a. Triangle Brass Manufacturing Company, Inc. (Trimco).
 - b. McKinney Products.
 - c. Rockwood.
 - d. Hager Manufacturing.
 - e. Ives Manufacturing.
2. Where hardware groups/sets have different information, refer to the following for clarification. Provide hardware groups/sets devices along with added devices as indicated on Drawings and detailed requirements for each type of device:
 - a. Non-rated Openings: Where not specified in hardware sets provide supply two flush bolts for inactive leaf of pairs of locked and latched doors. Locate centerline of top bolt not more than 78 inches from finished floor. Provide dustproof strike for bottom bolts, type as required for floor condition.
 - b. Rated Openings: Where not specified in hardware sets provide automatic flush bolt set as applicable for inactive leaf of pairs of doors. Provide dustproof strike for bottom bolts, type as required for floor condition.

D. Coordinators:

1. Manufacturers:

- a. Triangle Brass Manufacturing Company, Inc. (Trimco).
 - b. McKinney Products.
 - c. Rockwood.
 - d. Hager Manufacturing.
 - e. Ives Manufacturing.
2. Where hardware groups/sets have different information, refer to the following for clarification. Provide hardware groups/sets devices along with added devices as indicated on Drawings and detailed requirements for each type of device:
- a. Provide coordinator for fire rated or smoke labeled pairs of doors equipped with automatic flush bolts and those with vertical rod/mortise lock fire exit device combinations with astragals.
 - b. Provide filler bars for total opening width, closer mounting brackets to allow proper installation of stop mounted hardware without damaging coordinator, carry bars, and special preparation for top latches where applicable.

2.8 KEY SYSTEMS (CYLINDERS, CORES, AND KEYS)

- A. Where hardware groups/sets have different information, refer to the following for clarification. Provide hardware groups/sets devices along with added devices as indicated on drawings and detailed requirements for each type of device. Keying specifications below override hardware set/group nomenclature:
- B. Gun Lockers:
1. For all locking devices on gun lockers:
 - a. Provide complete keying system whether or not specified, hardware sets including gun locker cylinders/cores, lock cores, mortise cylinders, and rim cylinders keyed as directed by Owner in submittal process.
 - b. In addition to the devices specified in hardware group/sets below, coordinate devices in "Detention Furnishings". Gun locker permanent cylinders and keys in the following quantities (total quantity of keys part of bid package):
 - 1) 12 each: Rim or Mortise x appropriate cam x blocking rings as required - rim or mortise type and quantity as required by locking device.
 - 2) 12 each: Include cylinders above and final cores also (provide credit when the less expensive keying system submitted).
- C. BHMA Locking Device Key Systems (Cylinders, Cores, and Keys):
1. Manufacturers:
 - a. Schlage.
 - b. Owner's standard, no substitutions permitted.
 2. For all locking or dogging devices, provide complete keying system whether or not specified, hardware sets including lock cores, mortise cylinders, and rim cylinders keyed as directed by Owner in submittal process. Key System shall be:
 - a. Patented Schlage Primus Level 3 XP.
 - b. Owner's standard, no substitutions permitted.

- D. Keying Requirements:
1. Provide keyed, construction cores and keys during the construction period.
 - a. Provide full sized cylinders or brass construction cores and brass keys at all interior and exterior doors. Plastic cores are not permitted.
 - b. Construction control and operating keys and core shall not be part of the Owner's permanent keying system or furnished in the same keyway or key section as the Owner's permanent keying system. Permanent cores and keys prepared according to the accepted keying schedule shall be furnished to the Owner.
 2. Keying Meeting and Programming Schedule:
 - a. After hardware has been submitted and reviewed, arrange a keying matrix/programming meeting with Owner and hardware supplier/Vendor representing the ASSA Restricted Keyway system.
 - 1) Copies of the reviewed door and frame submittals shall be brought to the meeting with card reader and keyed doors highlighted for review.
 - 2) Follow procedures for keying meeting and programming schedule as outlined by the Door Hardware Institute. DHI procedures are based on example Door Hardware Institute core class entitled Masterkeying class #AHC200.
 - b. Keying meeting to produce a programming schedule/matrix based on the following:
 - 1) Furnish keys in the following quantities (total quantity of keys part of bid package):
 - a) 5 each Grand master-keys per set.
 - b) 6 each Masterkeys per set.
 - c) 3 each Change keys each lock, core or cylinder.
 - d) 5 each Permanent Extractor keys.
 - e) 9 each Construction masterkeys.
 - f) 2 each Construction Core Extractor keys.
 - g) Include 3 each change keys each lock, core or cylinder for gun lockers.
 - 2) Provide keying system expansion parameters.
 - a) Plan twenty changes directly under the grand.
 - b) Plan ten master keys.
 - c) Plan fifty changes each for each master
 - 3) Permanent keys and cores shall be stamped with the applicable key mark for identification. The visual key control marks or codes shall not include the actual key cuts.
 - 4) Permanent keys shall be stamped "Do Not Duplicate".
 - c. Furnish meeting Notes and three compete, typed copies of keying and programming schedule to Owner for final review.
 - d. Furnish keying and programming schedule to ASSA manufacturing factory for production of cores, cylinders and other keyed devices.
 3. Transmit pinned cores/cylinders as well as cut grand masterkeys, masterkeys,

change keys and other security keys to Owner by Registered Mail, return receipt requested.

4. Install permanent cores in presence of Owner.
- E. Fire Control Key Boxes:
1. Product: Rapid Entry System.
 2. Manufacturer and Product: Basis-of-Design: Knox Box 3200 Series x The Knox Co.
 3. Recessed mount, UL-listed, heavy-duty unit; fabricate from 1/4-inch-thick steel plate.
 4. Provide with restricted keying as required by Local Fire Department.
 5. Provide one box at each main entry from each parking area designated with a fire emergency lane.

2.9 CLOSING DEVICE

- A. Surface Mounted Closers:
1. Acceptable Manufacturers:
 - a. LCN Manufacturing – 4040 XP Series as scheduled.
- B. Where hardware groups/sets have different information, refer to the following for clarification. Provide hardware groups/sets devices along with added devices as indicated on drawings and detailed requirements for each type of device:
1. ANSI A156.4, Grade 1; UL Listed; meets UL 10C and SFM Standard 12-7-4 for positive pressure fire test.
 2. Closers shall have multi-size spring power adjustment to permit setting of spring from 1 through 6 with additional spring power available. Provide ADA compliant setting nomenclature during submittals as recommended by closer manufacturer.
 3. Submit correct closer type as to be able to install closers on non-public side of doors. Examples include, but are not limited to 1) interior side of storage/electrical type rooms; 2) not in corridors/public areas 3) stair side of stairway doors; and at exterior locations, install closers inside of building (in conditioned spaces).
 4. Installation Plates, Brackets, and Miscellaneous Adapters:
 - a. Provide drop plates, brackets, or adapters for arms as required to suit details and install as directed by manufacturer's templates.
 - 1) Furnish and install drop plates at reverse bevel doors and at doors with 170 degrees to 180 degrees swing.
 - 2) Furnish and install blade, angle or applied stops as required where frame does not permit installation of the standard soffit plate.

2.10 STOPS AND HOLDERS

- A. Floor and Wall Door Stops/Holders and Bumpers:
1. Acceptable Manufacturers:
 - a. Triangle Brass Manufacturing Company, Inc. (Trimco).
 - b. Ives Manufacturing.
 - c. Rockwood.

- d. Hager Manufacturing.
- e. McKinney Products.
- 2. Where hardware groups/sets have different information, refer to the following for clarification. Provide hardware groups/sets devices along with added devices as indicated on Drawings and detailed requirements for each type of device:
 - a. Stops, Bumpers and/or Holders shall meet the requirements of BHMA A156.16, Grade 1.
 - b. Coordinate required wall backing.

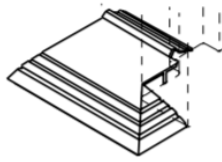
2.11 ACCESSORIES

- A. Kick/Mop Plates:
 - 1. Acceptable Manufacturers:
 - a. Triangle Brass Manufacturing Company, Inc. (Trimco).
 - b. Rockwood.
 - c. Hager Manufacturing.
 - d. Ives Manufacturing.
 - e. McKinney Products.
 - B. Where hardware groups/sets have different information, refer to the following for clarification. Provide hardware groups/sets devices along with added devices as indicated on Drawings and detailed requirements for each type of device
 - 1. Size at single doors:
 - a. Push side of door two inch less than door width. Hardware set/group nomenclature: 2 inches LDW.
 - b. Pull side and one inch less than door width. Hardware set/group nomenclature: 1-inch LDW.
 - 2. At pairs of doors:
 - a. Width shall be one inch less than door width unless doors have protective edge guards or center mullions.
 - 3. Height shall be 10 inches, unless otherwise indicated.
 - 4. At all rated doors (UL smoke or fire), furnish protection plates with engraved UL listing information (example: Trimco added part #ULS added to all kickplates specified below that are on UL or rated doors/openings).
- C. Smoke Seals, Intumescent Seals, Sound Seals, and/or Weatherstripping.
 - 1. Acceptable Manufacturers:
 - a. Pemko Manufacturing, Inc.
 - b. National Guard.
 - c. Zero International.
 - d. McKinney Products.
 - 2. No intumescent material is allowed on door frames. Where CBC requirements for positive pressure must be met, doors shall include all requirements as part of the door construction per 'Category A' guidelines as published by ITS/Warnock-Hersey. Only smoke gasketing applied around the perimeter of the frame to meet the 'S' smoke rating is permissible in instances where smoke control is required.

- D. Light or Sound Seals:
1. Acceptable Manufacturers:
 - a. Pemko Manufacturing, Inc. Basis-of-Design: 29310CS or 350CSR adjustable seals.
 - b. National Guard.
 - c. Zero International.
 - d. McKinney Products.
 2. Where hardware groups/sets have different information, refer to the following for clarification. Provide hardware groups/sets devices along with added devices as indicated on Drawings and detailed requirements for each type of device:
 - a. In the field cutting or notching of sound gasket hardware shall not be permitted.
 - b. Submit and supply 29310CS or 350CSR type gasketing in lengths appropriate for template hardware. Examples below are not exhaustive; see hardware and door templating requirements.
 - 1) When rim-type exit/panic devices are used in conjunction with the 29310CS or 350CSR, order different lengths of 29310CS or 350CSR for latching side jamb to coordinate with -type exit/panic device, surface mounted latch. Do not install seal at roller-type latch location.
 - 2) When stop mounted overhead closer devices are used in conjunction with the 29310CS or 350CSR, provide the correct drop plates, brackets, and/or closer arms to not cut or notch the 29310CS or 350CSR. Provide full, header width of 29310CS or 350CSR type devices. Example: If a parallel arm closer is utilized then provide offset arms like those used for surface mounted overhead stops, drop plates, and brackets.
- E. Door Silencers:
1. Acceptable Manufacturers:
 - a. Ives Manufacturing.
 - b. Triangle Brass Manufacturing Company, Inc. (Trimco).
 - c. Rockwood.
 - d. Hager Manufacturing.
 - e. McKinney Products.
- F. Astragals, Door Bottoms, and Thresholds:
1. Acceptable Manufacturers:
 - a. Pemko Manufacturing, Inc.
 - b. National Guard Products (NGP).
 - c. Zero International.
 - d. McKinney Products.
 2. Thresholds shall comply with CBC 2016 and shall not exceed 1/2 inch in height.
 3. Thresholds shall wrap frame stops (cut around stops, then continue into rabbits and face of frame).
 - a. Whether or not specified below, where thresholds are larger than frames

all thresholds to have beveled miter ends.

- b. 45-degree miter cut and a closed end, welded with returns to door/frame (example: NGP manufacturing nomenclature RCE throughout).



- G. Drip Guard:
 1. Provide at exterior doors exposed to rain.
 2. Size: Full Frame Width (FFW).
 3. Provide devices painted to match adjacent frame. See Section 09 91 00 for paint and primer requirements.

2.12 POWER SUPPLIES, ELECTRIFIED HARDWARE, AND WIRES

- A. Door Position Switches:
 1. Refer to and coordinate with Security Drawings.
- B. Power Supplies, Wires, and Relays:
 1. Where hardware groups/sets have different information (number of hinge wires and power supply information), refer to the following specifications for clarification and submit according to complete and intended electrified system per Contract Documents. See Architectural and Security drawings and specifications.
 - a. Coordinate use of power supplies with door and frame locations. Provide power supplies, relay, and battery backup units as part of the overall system in accordance with the manufacturer's warranty and system requirements. UL listed for applicable use; housed in an approved enclosure.
 - b. Output shall be filtered and regulated. Relay, timer, and logic modules shall be provided as required for interface to indicated security components, and shall be assembled, connected and fully contained within the power supply enclosure.
 - c. Provide required connections to accommodate fire alarm/life safety system and/or security electronics for remote site monitoring of all electrified components and functions.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine doors and frames and verify mounting locations as indicated on shop drawings.
- B. Report unacceptable conditions to the Architect. Begin installation only when unacceptable conditions have been corrected.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's printed instructions and approved shop drawings.
- B. Door-Floor Clearances: Unless otherwise shown, provide the following door-floor

clearances:

1. Labeled doors: 3/8 inch maximum over floor or threshold.
2. No threshold: 3/8 inch maximum for metal and wood doors.
3. With threshold: 1/8 inch.
4. Carpet: 1/8 inch over top of nap.

C. Hardware Placement:

1. Unless otherwise shown or required by CBC 2016, ADA Act - 2010 Standards for Accessible Design and/or Title 24, place hardware at the following heights:
 - a. Hinges: Door and frame manufacturer's standard scope per additional specifications and plans.
 - b. Lever handles for latchsets, lockset and panic/exit device pull, lever trim:
 - 1) 38 inches above finish floor/surface.
 - 2) Verify manufacturer's template with door design.
 - c. Panic devices push bar:
 - 1) Panic hardware shall be so mounted / centered between 36 inches and 44 inches above finished floor or ground.
 - 2) Verify manufacturer's template with door design to meet CBC 2016 exterior, pull side trim.
2. Hardware for door handles, pulls, latches, locks and other operating devices for use on means of egress doors shall comply with SFM Standard 12-10-2, Section 12-10-202 as contained in CCR Title 24, Part 12.

D. Installation:

1. Except for hinges, do not install hardware until painting and finishing work is completed.
2. Pre-drill pilot holes in wood for screws. Drill and tap for surface mounted hardware on metal.
3. Hinges: Set hinges snug and flat in mortises. Hand turn screws to flat seat – do not drive.
4. Locksets: Install locks with keyways in proper position. Install levers, roses, and escutcheons firmly affixed.
5. Closers: Mount door closers for maximum swing of door before setting stops. Closers shall have sweep period adjusted to minimum of 5 seconds for a door/gate to close from the 90 degree position to the 12 degree position.
6. Floor Stops: Floor stops shall be installed a maximum of 4 inches from adjacent walls.
7. Silencers: Set in place before adjusting strikes.
8. Thresholds and Raindrips: Set in waterproof sealant and fasten anchors in pre-drilled countersunk holes 18 inch on center maximum spacing and within 3 inches of each end. Minimum three anchors per threshold.

3.3 PAINT OR FIELD FINISHES

- A. Coordinate with Contact Documents including, but not limited to, Section 09 91 00 for paint and primer requirements.

- B. Fire rated labels on doors and frames shall not be painted.

3.4 ADJUSTING

- A. Adjust parts for smooth, uniform operation.
- B. Lubricate moving parts with manufacturer recommended lubricant.
- C. Replace units that cannot be adjusted and lubricated to operate freely and smoothly as intended for the application.
- D. Adjust door closer devices:
 - 1. Adjust closer operating effort.
 - a. Interior and Exterior Doors: not to exceed 5.0 pounds force.
 - b. When fire doors are required, the maximum effort to operate the door may be increased to the minimum allowed by the appropriate administrative authority, not to exceed 15 pounds opening force.
 - 2. Adjust closer delay and operating speeds to comply with requirements of 2016 CBC 11B-404.2.8.1 and ADA – Americans with Disabilities Act - 2010 Standards for Accessible Design.
 - a. Doors/gates closers, when provided, shall have sweep period adjusted: minimum of 5 seconds for a door/gate to close from the 90 degree position to the 12 degree position.

3.5 CLEANING

- A. Clean as recommended by manufacturer. Do not use materials or methods which may damage finish or surrounding construction.

3.6 HARDWARE SCHEDULE

- A. Manufacturers Legend:

Code	Name
MC	McKinney Manufacturing
SC	Schlage Manufacturing
LC	LCN Closers
VO	Von Duprin Manufacturing
IV	H.B. Ives Manufacturing
TR	Trimco Manufacturing
PE	Pemko Manufacturing
RX	Rixson Manufacturing
SN	Securitron Manufacturing

- B. Hardware Columns - Example (Legend):

Qty	Device Description	Device # (include specification language)	Finish	Manu
1	-----	-----	--	--

- C. The “Request-to-Exit” feature as described below is a security feature that announces/tells the security system if occupant is leaving the building interior area and similar to a motion-sensor the “Request-to-Exit” switch or device does not affect egress of the doors. Unless Noted, all doors in hardware group/sets are free egress at all times with no special knowledge to exit.

- D. The following hardware sets are intended to establish type and standard of quality when

used together with the requirements of this Section. See above Section and related Sections including Division 01.

1. Examine Contract Documents and furnish proper hardware for door openings.
2. Refer to Door Schedule on the Drawings for Hardware Group/Set assignments for each opening.

Blank space below and after a Group/Set is intentional to avoid, if possible, splitting a Hardware Group/Set onto two pages.

Exterior Hardware Sets (Typically Two-Digit Set Numbers)

Hardware Group/Set #01: Not Used.

Hardware Group/Set #02

	Ea.	Hinges	T4A3386 x NRP (quantity size per Section 08 71 00)	630	MC
1	Ea.	Electrified Power Transfer Hinges	T4A3386 QC8 (8-wire, size per Section 08 71 00)	630	MC
1	Ea.	Electrified Lockset	L9092_ EU RX 06A	630	SC
1	Ea.	Primus I/C Cylinders (Rim or Mortise)	20-757 or 20-763 x appropriate cam x blocking rings as required (rim or mortise type and quantity as required by locking device)	626	SC
1	Ea.	Permanent Core	20-740	626	SC
1	Ea.	Closer	4040XP EDA x security torx fasteners	689	LC
2	Ea.	Kick Plate	KO050 16" tall x 2" LDW (less door width) x B4E (beveled edges) x counter sunk where door allows	630	TR
1	Ea.	Floor Stop	1209	630	TR
1	Ea.	Seal (weatherstripping)	S88D seals (head and jambs)		PE
1	Ea.	Door Bottom Sweep	216A x security torx fasteners		PE
1	Ea.	Threshold	2727A or 176A or per detail (sized to fit the condition) x security torx fasteners by Pemko or approved seal manufacturer		
1	Ea.	Overhead Rain Drip	Per architectural details and flashing at uncovered areas (or by door manufacturer to meet no water penetration warranties – verify before submittals). For hollow metal doors, provide 346C x FFW full raindrips by Pemko or approved equal.		
1	Ea.	Door Position Switch (also known as Alarm Contact, Door Contact)	#1078D x Interlogix manufacturing (coordinate with Divisions 25-28 and applicable drawings).		
1	Ea.	Request-to-Exit Sensor (see free egress Note in above specifications)	Parts/devices specified in above locking hardware (coordinate with Divisions 25-28 and applicable drawings).		
1	Ea.	Coordination task for security and/or electrical design and additional non-Division 08 Section scope (including but not limited to wire / connectivity from ground or ceiling through frame to electrified hardware)	By security or electrical as required per Contract Documents: - Coordinate with security or electrical Divisions 25-28 and applicable drawings		
1	Ea.	Power Supply	Coordinate with security Divisions 28 and applicable drawings as hardware does not include.		

Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including, but not limited to, additional hardware devices requirements in the above specification language, architectural plans and full specification documents).

Hardware Group/Set #03

	Ea.	Hinges	T4A3386 x NRP (quantity size per Section 08 71 00)	630	MC
1	Ea.	Rim-Type Exit/Panic (typically exit-only type application)	RX PA 99NL-OP x 110NL (key override for emergency responders only – coordinate with Z-Pull below)	626	VO
1	Ea.	ADA Z Pull	#Z100-20500 series installed face down and templated center hole for final cylinder and rings to be installed over #Z100-20500	630	TR
1	Ea.	Primus I/C Cylinders (Rim or Mortise)	20-757 or 20-763 x appropriate cam x blocking rings as required (rim or mortise type and quantity as required by locking device)	626	SC
1	Ea.	Permanent Core	20-740	626	SC
1	Ea.	Closer x Stop Arm	4040XP x CUSH	689	LC
1	Ea.	Kick Plate	KO050 16" tall x 2" LDW (less door width) x B4E (beveled edges) x counter sunk where door allows	630	TR
1	Ea.	Seal (weatherstripping)	S88D seals (head and jambs)		PE
1	Ea.	Door Bottom Sweep	216A x security torx fasteners		PE
1	Ea.	Threshold	2727A or 176A or per detail (sized to fit the condition) x security torx fasteners by Pemko or approved seal manufacturer		
1	Ea.	Overhead Rain Drip	Per architectural details and flashing at uncovered areas (or by door manufacturer to meet no water penetration warranties – verify before submittals). For hollow metal doors, provide 346C x FFW full raindrips by Pemko or approved equal.		
1	Ea.	Door Position Switch (also known as Alarm Contacts)	#1078D x Interlogix manufacturing (coordinate with Divisions 25-28 and applicable drawings).		
<p>Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including, but not limited to, additional hardware devices requirements in the above specification language, architectural plans and full specification documents).</p>					

Hardware Group/Set #04

	Ea.	Hinges	T4A3386 x NRP (quantity size per Section 08 71 00)	630	MC
1	Ea.	Rim-Type Exit/Panic (typically exit-only type application)	RX PA 99NL-OP x 110NL (key override for emergency responders only – coordinate with Z-Pull below)	626	VO
1	Ea.	ADA Z Pull	#Z100-20500 series installed face down and templated center hole for final cylinder and rings to be installed over #Z100-20500	630	TR
1	Ea.	Primus I/C Cylinders (Rim or Mortise)	20-757 or 20-763 x appropriate cam x blocking rings as required (rim or mortise type and quantity as required by locking device)	626	SC
1	Ea.	Permanent Core	20-740	626	SC
1	Ea.	Closer x Stop Arm	4040XP x CUSH	689	LC
2	Ea.	Kick Plate	KO050 16" tall x 2" LDW (less door width) x B4E (beveled edges) x counter sunk where door allows	630	TR
1	Ea.	Seal (weatherstripping)	S88D seals (head and jambs)		PE
2	Ea.	Door Bottom Sweep	216A x security torx fasteners		PE
1	Ea.	Threshold	2727A or 176A or per detail (sized to fit the condition) x security torx fasteners by Pemko or approved seal manufacturer		
1	Ea.	Overhead Rain Drip	Per architectural details and flashing at uncovered areas (or by door manufacturer to meet no water penetration warranties – verify before submittals). For hollow metal doors, provide 346C x FFW full raindrips		

			by Pemko or approved equal.		
2	Ea.	Manual Flush Bolt (with dust proof strike)	FB457xDP2 Dust Proof Strike x Security Torx Fasteners	630	IV
1	Ea.	Astragal	Furnish and Install Welded, Ground Smooth and Prime/Painted by Door Manufacturer x S77 Seal		PE
1	Ea.	Astragal Seal	S77D Perforated Feature Seal		PE
Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including, but not limited to, additional hardware devices requirements in the above specification language, architectural plans and full specification documents).					

Hardware Group/Set #05

	Ea.	Hinges	T4A3386 x NRP (quantity size per Section 08 71 00)	630	MC
1	Ea.	Storeroom-Type Lockset	LV9080T X 06L x Less Outside Trim (interior lever only with Z pull at exterior) x cylinder length and size required for Z-pull x security torx fasteners	630	SC
1	Ea.	Z Pull	#Z100-20500 series installed face down and templated center hole for final cylinder and rings to be installed over #Z100-20500	630	TR
1	Ea.	Primus I/C Cylinders (Rim or Mortise)	20-757 or 20-763 x appropriate cam x blocking rings as required (rim or mortise type and quantity as required by locking device)	626	SC
1	Ea.	Permanent Core	20-740	626	SC
1	Ea.	Overhead Stop	9ADJ SERIES (-336 or size as required) x security torx fasteners	630	RX
1	Ea.	Kick Plate	KO050 16" tall x 2" LDW (less door width) x B4E (beveled edges) x counter sunk where door allows	630	TR
1	Ea.	Seal (weatherstripping)	S88D seals (head and jambs)		PE
1	Ea.	Door Bottom Sweep	216A x security torx fasteners		PE
1	Ea.	Threshold	2727A or 176A or per detail (sized to fit the condition) x security torx fasteners by Pemko or approved seal manufacturer		
1	Ea.	Overhead Rain Drip	Per architectural details and flashing at uncovered areas (or by door manufacturer to meet no water penetration warranties – verify before submittals). For hollow metal doors, provide 346C x FFW full raindrips by Pemko or approved equal.		
Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including, but not limited to, additional hardware devices requirements in the above specification language, architectural plans and full specification documents).					

Hardware Group/Set #06

	Ea.	Hinges	T4A3386 x NRP (quantity size per Section 08 71 00)	630	MC
1	Ea.	Electrified Power Transfer Hinges	T4A3386 QC8 (8-wire, size per Section 08 71 00)	630	MC
1	Ea.	Electrified REX Mortise-Type Panic Device – Lever	WP-RX 9975EO	626	VO
1	Ea.	Closer – final to be selected	4040XP EDA x security torx fasteners	689	LC
1	Ea.	Kick Plate	KO050 16" tall x 2" LDW (less door width) x B4E (beveled edges) x counter sunk where door allows	630	TR
1	Ea.	Floor Stop	1209HA	630	TR
1	Ea.	Seal	S88D seals (head and jambs)		PE
1	Ea.	Threshold	176A or per detail (sized to fit the condition) x security torx fasteners by Pemko or approved seal manufacturer		
1	Ea.	Overhead Rain Drip	For hollow metal doors, provide 346C x FFW full raindrips by Pemko or approved equal.		
1	Ea.	Door Position Switch (also known as Alarm Contacts)	#2507AD single pole, double throw x Interlogix manufacturing (coordinate with Divisions 25-28 and applicable drawings).		
1	Ea.	Request-to-Exit Sensor (see free egress Note in above specifications)	Parts/devices specified in above locking hardware (coordinate with Divisions 25-28 and applicable drawings).		
<p>Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including, but not limited to, additional hardware devices requirements in the above specification language, architectural plans and full specification documents).</p>					

Hardware Group/Set #06A					
—	Ea.	Hinges	T4A3386 x NRP (quantity size per Section 08 71 00)	630	MC
1	Ea.	Storeroom-Type Lockset	LV9080T X 06L x Less Outside Trim (interior lever only with Z pull at exterior) x cylinder length and size required for Z-pull x security torx fasteners	630	SC
1	Ea.	Z Pull	#Z100-20500 series installed face down and templated center hole for final cylinder and rings to be installed over #Z100-20500	630	TR
1	Ea.	Primus I/C Cylinders (Rim or Mortise)	20-757 or 20-763 x appropriate cam x blocking rings as required (rim or mortise type and quantity as required by locking device)	626	SC
1	Ea.	Permanent Core	20-740	626	SC
1	Ea.	Closer	4040XP EDA x security torx fasteners	689	PE
1	Ea.	Seal (weatherstripping)	S88D seals (head and jambs)		PE
1	Ea.	Door Bottom Sweep	216A x security torx fasteners		PE
1	Ea.	Threshold	2727A or 176A or per detail (sized to fit the condition) x security torx fasteners by Pemko or approved seal manufacturer		
1	Ea.	Overhead Rain Drip	Per architectural details and flashing at uncovered areas (or by door manufacturer to meet no water penetration warranties – verify before submittals). For hollow metal doors, provide 346C x FFW full raindrips by Pemko or approved equal.		
<p>Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including, but not limited to, additional hardware devices requirements in the above specification language, architectural plans and full specification documents).</p>					

Hardware Group/Set #07

—	Ea.	Hinges	T4A3386 x NRP (size and quantity per Section 08 71 00) x security torx fasteners	630	MC
2	Ea.	Manual Flush Bolts (with dust proof strike)	FB457 x DP2 dust proof strike x security torx fasteners	630	IV
1	Ea.	Storeroom-Type Lockset	LV9080T X 06L x Less Outside Trim (interior lever only with Z pull at exterior) x cylinder length and size required for Z-pull x security torx fasteners	630	SC
1	Ea.	Z Pull	#Z100-20500 series installed face down and templated center hole for final cylinder and rings to be installed over #Z100-20500	630	TR
1	Ea.	Primus I/C Cylinders (Rim or Mortise)	20-757 or 20-763 x appropriate cam x blocking rings as required (rim or mortise type and quantity as required by locking device). Cylinder length, size and rings required for Z-pull	626	SC
1	Ea.	Permanent Core	20-740	626	SC
2	Ea.	Overhead Stop	9ADJ SERIES (-336 or size as required) x security torx fasteners	630	RX
2	Ea.	Kick Plate	KO050 16" tall x 2" LDW (less door width) x B4E (beveled edges) x counter sunk where door allows	630	TR
1	Ea.	Seal (weatherstripping)	S88D Perforation Feature (head and jambs)		PE
1	Ea.	Astragal Seal (weatherstripping)	S77D Perforation Feature seal		PE

1	Ea.	Astragal	Furnish and install welded, ground smooth and prime/painted astragal by door manufacturer x S77 seal	PE
2	Ea.	Door Bottom Sweep	216A x security torx fasteners	PE
1	Ea.	Threshold	2727A or 176A (see detail or verify in field if existing sill condition: provide in-kind replacement sized to fit the condition) x security torx fasteners	PE
1	Ea.	Overhead Rain Drip	Per architectural details and flashing at uncovered areas (or by door manufacturer to meet no water penetration warranties – verify before submittals). For hollow metal doors, provide 346C x FFW full raindrips by Pemko or approved equal.	
2	Ea.	Door Position Switch (also known as Alarm Contacts)	#1078D x Interlogix manufacturing (coordinate with Divisions 25-28 and applicable drawings).	
<p>Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including, but not limited to, additional hardware devices requirements in the above specification language, architectural plans and full specification documents).</p>				

Hardware Group/Set #08					
—	Ea.	Hinges	T4A3386 x NRP (size and quantity per Section 08 71 00) x security torx fasteners	630	MC
1	Ea.	Storeroom-Type Lockset	LV9080T X 06L x Less Outside Trim (interior lever only with Z pull at exterior) x cylinder length and size required for Z-pull x security torx fasteners	630	SC
1	Ea.	Z Pull	#Z100-20500 series installed face down and templated center hole for final cylinder and rings to be installed over #Z100-20500	630	TR
1	Ea.	Primus I/C Cylinders (Rim or Mortise)	20-757 or 20-763 x appropriate cam x blocking rings as required (rim or mortise type and quantity as required by locking device). Cylinder length, size and rings required for Z-pull	626	SC
1	Ea.	Permanent Core	20-740	626	SC
1	Ea.	Overhead Stop	9ADJ SERIES (-336 or size as required) x security torx fasteners	630	RX
1	Ea.	Kick Plate	KO050 16" tall x 2" LDW (less door width) x B4E (beveled edges) x counter sunk where door allows	630	TR
1	Ea.	Seal (weatherstripping)	S88D Perforation Feature (head and jambs)		PE
1	Ea.	Door Bottom Sweep	216A x security torx fasteners		PE
1	Ea.	Threshold	2727A or 176A (see detail or verify in field if existing sill condition: provide in-kind replacement sized to fit the condition) x security torx fasteners		PE
1	Ea.	Overhead Rain Drip	Per architectural details and flashing at uncovered areas (or by door manufacturer to meet no water penetration warranties – verify before submittals). For hollow metal doors, provide 346C x FFW full raindrops by Pemko or approved equal.		
1	Ea.	Door Position Switch (also known as Alarm Contacts)	#1078D x Interlogix manufacturing (coordinate with Divisions 25-28 and applicable drawings).		
<p>Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including, but not limited to, additional hardware devices requirements in the above specification language, architectural plans and full specification documents).</p>					

Interior Hardware Sets (Typically Three-Digit Set Numbers)

Hardware Group/Set #101

—	Ea.	Hinges	T4A3386 x NRP (size and quantity per Section 08 71 00) x security torx fasteners	630	MC
1	Ea.	Electrified Power Transfer Hinges	T4A3386 QC8 (8-wire, size per Section 08 71 00)	630	MC
1	Ea.	Electrified Storeroom-Type Lockset	L9092T x EU X 06L x RX x security torx fasteners	630	SC
1	Ea.	Primus I/C Cylinders (Rim or Mortise)	20-757 or 20-763 x appropriate cam x blocking rings as required (rim or mortise type and quantity as required by locking device)	626	SC
1	Ea.	Permanent Core	20-740	626	SC
1	Ea.	Closer	4040XP EDA x security torx fasteners	689	LC
2	Ea.	Kick Plate	KO050 16" tall x 2" LDW (less door width) x B4E (beveled	630	TR

			edges) x counter sunk where door allows		
1	Ea.	Door Stop	#1209 x security torx fasteners x security torx fasteners	630	TR
1	Ea.	Seal (for rated or sound dampening conditions)	S88D Perforation Feature (head and jambs)		PE
1	Ea.	Door Position Switch (also known as Alarm Contact, Door Contact)	#1078D x Interlogix manufacturing (coordinate with Divisions 25-28 and applicable drawings).		
1	Ea.	Request-to-Exit Sensor (see free egress Note in above specifications)	Parts/devices specified in above locking hardware (coordinate with Divisions 25-28 and applicable drawings).		
1	Ea.	Coordination task for security and/or electrical design and additional non-Division 08 Section scope (including but not limited to wire / connectivity from ground or ceiling through frame to electrified hardware)	By security or electrical as required per Contract Documents: - Coordinate with security or electrical Divisions 25-28 and applicable drawings.		
1	Ea.	Power Supply	Coordinate with security Divisions 28 and applicable drawings as hardware does not include.		


Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including, but not limited to, additional hardware devices requirements in the above specification language, architectural plans and full specification documents).

Hardware Group/Set #102

—	Ea.	Hinges	T4A3386 x NRP (size and quantity per Section 08 71 00) x security torx fasteners	630	MC
1	Ea.	Classroom-Type Lockset	L9070T X 06L x security torx fasteners	630	SC
1	Ea.	Primus I/C Cylinders (Rim or Mortise)	20-757 or 20-763 x appropriate cam x blocking rings as required (rim or mortise type and quantity as required by locking device)	626	SC
1	Ea.	Permanent Core	20-740	626	SC
1	Ea.	Closer	4040XP EDA x security torx fasteners (provide special templates throughout project including, but not limited to concealed overhead stop and closer arms)	689	LC
1	Ea.	Concealed Overhead Stop	1ADJ (-336 or size as required)	630	RX
2	Ea.	Kick Plate	KO050 16" tall x 2" LDW (less door width) x B4E (beveled edges) x counter sunk where door allows	630	TR
1	Ea.	Seal (for rated or sound dampening conditions)	S88D Perforation Feature (head and jambs)		PE

Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including, but not limited to, additional hardware devices requirements in the above specification language, architectural plans and full specification documents).

Hardware Group/Set #103

—	Ea.	Hinges	T4A3386 x NRP (size and quantity per Section 08 71 00) x security torx fasteners	630	MC
1	Ea.	Privacy x Occupancy Indicator (exterior side lever can be left unlocked. Emergency cylinder/key override):	L9456T x 06A x #L283-722 (interior ADA thumbturn and exterior side emergency cylinder/key override) 	630	SC
1	Ea.	Primus I/C Cylinders (Rim or Mortise)	20-757 or 20-763 x appropriate cam x blocking rings as required (rim or mortise type and quantity as required by locking device)	626	SC
1	Ea.	Permanent Core	20-740	626	SC
1	Ea.	Closer	4040XP EDA (installed push-side of door if door swings out) or 4040XP x REG (installed pull-side of door if door swings in) per specifications	689	LC
2	Ea.	Kick Plate	KO050 16" tall x 2" LDW (less door width) x B4E (beveled edges) x counter sunk where door allows	630	TR
1	Ea.	Door Stop	1270CV (provide #1209 x security torx fasteners x 630 at door #103 and other doors where wall stop will not meet door lever)	626	TR
1	Ea.	Seal (for rated or sound dampening conditions)	S88D Perforation Feature (head and jambs)		PE

Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including, but not limited to, additional hardware devices requirements in the above specification language, architectural plans and full specification documents).

Hardware Group/Set #104

—	Ea.	Hinges	T4A3386 x NRP (size and quantity per Section 08 71 00) x security torx fasteners	630	MC
1	Ea.	Office-Type Lockset	L9050T X 06L x security torx fasteners	630	SC
1	Ea.	Primus I/C Cylinders (Rim or Mortise)	20-757 or 20-763 x appropriate cam x blocking rings as required (rim or mortise type and quantity as required by locking device)	626	SC
1	Ea.	Permanent Core	20-740	626	SC
2	Ea.	Kick Plate	KO050 16" tall x 2" LDW (less door width) x B4E (beveled edges) x counter sunk where door allows	630	TR
1	Ea.	Door Stop	1270CV	626	TR
1	Ea.	Seal (sound dampening conditions)	S88D Perforation Feature (head and jambs)		PE

Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including, but not limited to, additional hardware devices requirements in the above specification language, architectural plans and full specification documents).

Hardware Group/Set #105

—	Ea.	Hinges	T4A3386 x NRP (size and quantity per Section 08 71 00) x security torx fasteners	630	MC
1	Ea.	Classroom-Type Lockset	L9070T X 06L x security torx fasteners	630	SC
1	Ea.	Primus I/C Cylinders (Rim or Mortise)	20-757 or 20-763 x appropriate cam x blocking rings as required (rim or mortise type and quantity as required by locking device)	626	SC
1	Ea.	Permanent Core	20-740	626	SC
2	Ea.	Kick Plate	KO050 16" tall x 2" LDW (less door width) x B4E (beveled edges) x counter sunk where door allows	630	TR
1	Ea.	Door Stop	#1209 x security torx fasteners	630	TR
3	Ea.	Door Silencers	SR64 or SR65 (As Required)	GR	IV

Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including, but not limited to, additional hardware devices requirements in the above specification language, architectural plans and full specification documents).

Hardware Group/Set #106

—	Ea.	Hinges	T4A3386 x NRP (size and quantity per Section 08 71 00) x security torx fasteners	630	MC
1	Ea.	Passage Latchset	L9010 X 06L x security torx fasteners	630	SC
1	Ea.	Closer	4040XP x REG	689	LC
2	Ea.	Kick Plate	KO050 16" tall x 2" LDW (less door width) x B4E (beveled edges) x counter sunk where door allows	630	TR
1	Ea.	Door Stop	#1209 x security torx fasteners	630	TR
1	Ea.	Seal (fire rated or sound dampening conditions)	S88D Perforation Feature (head and jambs)		PE

Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including, but not limited to, additional hardware devices requirements in the above specification language, architectural plans and full specification documents).

Hardware Group/Set #107

—	Ea.	Hinges	T4A3386 x NRP (size and quantity per Section 08 71 00) x security torx fasteners	630	MC
1	Ea.	Electrified Power Transfer Hinges	T4A3386 QC8 (6-wire, size per Section 08 71 00)	630	MC
1	Ea.	Fire Rated Rim Exit/Panic with Fail-Safe Exterior Side Lever	RSS x ALK AX 99NL x 996NL R&V x Lever	626	VO
2	Ea.	Primus I/C Cylinders (Rim or Mortise)	20-757 or 20-763 x appropriate cam x blocking rings as required (rim or mortise type and quantity as required by locking device)	626	SC
2	Ea.	Permanent Core	20-740	626	SC
1	Ea.	Closer	4040XP EDA x security torx fasteners	689	LC
2	Ea.	Kick Plate	KO050 16" tall x 2" LDW (less door width) x B4E (beveled edges) x counter sunk where door allows	630	TR
1	Ea.	Door Stop	#1214 x security torx fasteners	630	TR
1	Ea.	Seal (for rated or sound dampening conditions)	S88D Perforation Feature (head and jambs)		PE

Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including, but not limited to, additional hardware devices requirements in the above specification language, architectural plans and full specification documents).

language, architectural plans and full specification documents).

Hardware Group/Set #108

—	Ea.	Hinges	T4A3386 x NRP (size and quantity per Section 08 71 00) x security torx fasteners	630	MC
1	Ea.	Classroom-Type Lockset	L9070T X 06L x security torx fasteners	630	SC
1	Ea.	Primus I/C Cylinders (Rim or Mortise)	20-757 or 20-763 x appropriate cam x blocking rings as required (rim or mortise type and quantity as required by locking device)	626	SC
1	Ea.	Permanent Core	20-740	626	SC
1	Ea.	Overhead Stop	9ADJ SERIES (-336 or size as required) x security torx fasteners x special pull-side installation	630	RX
2	Ea.	Kick Plate	KO050 16" tall x 2" LDW (less door width) x B4E (beveled edges) x counter sunk where door allows	630	TR
3	Ea.	Door Silencers	SR64 or SR65 (as required)	GR	IV

Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including, but not limited to, additional hardware devices requirements in the above specification language, architectural plans and full specification documents).

Hardware Group/Set #109

—	Ea.	Hinges	T4A3386 x NRP (size and quantity per Section 08 71 00) x security torx fasteners	630	MC
1	Ea.	Storeroom-Type Lockset	L9080T X 06L x security torx fasteners	630	SC
1	Ea.	Primus I/C Cylinders (Rim or Mortise)	20-757 or 20-763 x appropriate cam x blocking rings as required (rim or mortise type and quantity as required by locking device)	626	SC
1	Ea.	Permanent Core	20-740	626	SC
1	Ea.	Closer	4040XP CUSH (installed push-side of door if door swings out) or 4040XP x REG (installed pull-side of door if door swings in) per specifications	689	LC
2	Ea.	Kick Plate	KO050 16" tall x 2" LDW (less door width) x B4E (beveled edges) x counter sunk where door allows	630	TR
1	Ea.	Auxiliary Door Stop	#1209 x security torx fasteners	630	TR
1	Ea.	Seal (for rated or sound dampening conditions)	S88D Perforation Feature (head and jambs)		PE

Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including, but not limited to, additional hardware devices requirements in the above specification language, architectural plans and full specification documents).

Hardware Group/Set #110

—	Ea.	Hinges	T4A3386 x NRP (size and quantity per Section 08 71 00) x security torx fasteners	630	MC
1	Ea.	Storeroom-Type Lockset	L9080T X 06L x security torx fasteners	630	SC
1	Ea.	Primus I/C Cylinders (Rim or Mortise)	20-757 or 20-763 x appropriate cam x blocking rings as required (rim or mortise type and quantity as required by locking device)	626	SC
1	Ea.	Permanent Core	20-740	626	SC
2	Ea.	Kick Plate	KO050 16" tall x 2" LDW (less door width) x B4E (beveled edges) x counter sunk security fasteners where door allows	630	TR
1	Ea.	Auxiliary Door Stop	#1209 x security torx fasteners	630	TR
3	Ea.	Door Silencers	SR64 or SR65 (as required)	GR	IV
<p>Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including, but not limited to, additional hardware devices requirements in the above specification language, architectural plans and full specification documents).</p>					

Hardware Group/Set #111

—	Ea.	Hinges	T4A3386 x NRP (size and quantity per Section 08 71 00) x security torx fasteners	630	MC
1	Ea.	Electrified Power Transfer Hinges	T4A3386 QC8 (8-wire, size per Section 08 71 00)	630	MC
1	Ea.	Electrified Institutional-Type Lockset	L9095T x EU X 06L x RX x security torx fasteners	630	SC
1	Ea.	Primus I/C Cylinders (Rim or Mortise)	20-757 or 20-763 x appropriate cam x blocking rings as required (rim or mortise type and quantity as required by locking device)	626	SC
2	Ea.	Permanent Core	20-740	626	SC
1	Ea.	Closer	4040XP EDA x security torx fasteners	689	LC
2	Ea.	Kick Plate	KO050 16" tall x 2" LDW (less door width) x B4E (beveled edges) x counter sunk where door allows	630	TR
1	Ea.	Door Stop	#1209 x security torx fasteners x security torx fasteners	630	TR
1	Ea.	Seal (for rated or sound dampening conditions)	S88D Perforation Feature (head and jambs)		PE
1	Ea.	Door Position Switch (also known as Alarm Contact, Door Contact)	#1078D x Interlogix manufacturing (coordinate with Divisions 25-28 and applicable drawings).		
1	Ea.	Request-to-Exit Sensor (see free egress Note in above specifications)	Parts/devices specified in above locking hardware (coordinate with Divisions 25-28 and applicable drawings).		
1	Ea.	Coordination task for security and/or electrical design and additional non-Division 08 Section scope (including but not limited to wire / connectivity from ground or ceiling through frame to electrified hardware)	By security or electrical as required per Contract Documents: - Coordinate with security or electrical Divisions 25-28 and applicable drawings.		
1	Ea.	Power Supply	Coordinate with security Divisions 28 and applicable drawings as hardware does not include.		

Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including, but not limited to, additional hardware devices requirements in the above specification language, architectural plans and full specification documents).

Hardware Group/Set #112

—	Ea.	Hinges	T4A3386 x NRP (size and quantity per Section 08 71 00) x security torx fasteners	630	MC
1	Ea.	Institutional-Type Lockset	L9082T X 06L x security torx fasteners	630	SC
1	Ea.	Primus I/C Cylinders (Rim or Mortise)	20-757 or 20-763 x appropriate cam x blocking rings as required (rim or mortise type and quantity as required by locking device)	626	SC
1	Ea.	Permanent Core	20-740	626	SC
1	Ea.	Closer	4040XP EDA (installed push-side of door if door swings out) or 4040XP x REG (installed pull-side of door if door swings in) per specifications	689	LC
2	Ea.	Kick Plate	KO050 16" tall x 2" LDW (less door width) x B4E (beveled edges) x counter sunk where door allows	630	TR
1	Ea.	Door Stop	#1209 x security torx fasteners	630	TR
1	Ea.	Seal (fire rated conditions)	S88D Perforation Feature (head and jambs)		PE

Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including, but not limited to, additional hardware devices requirements in the above specification language, architectural plans and full specification documents).

Hardware Group/Set #113

—	Ea.	Hinges	T4A3386 x NRP (size and quantity per Section 08 71 00) x security torx fasteners	630	MC
1	Ea.	Deadbolt	L463T	630	SC
1	Ea.	Permanent Core	20-740	626	SC
1	Ea.	Flush Pull	1111A	626	TR
1	Ea.	Permanent Core	20-740	626	SC
1	Ea.	Seal (sound dampening conditions)	S88D Perforation Feature (head and jambs)		PE

Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including, but not limited to, additional hardware devices requirements in the above specification language, architectural plans and full specification documents).

Hardware Group/Set #114

—	Ea.	Hinges	T4A3386 x NRP (size and quantity per Section 08 71 00) x security torx fasteners	630	MC
1	Ea.	Deadbolt	L463T	630	SC
1	Ea.	Permanent Core	20-740	626	SC
1	Ea.	Closer	LCN 2215 x Security Torx Fasteners	689	LC
1	Ea.	Threshold	2727A x Security Torx Fasteners		PE
1	Ea.	Flush Pull	1111A	626	TR
1	Ea.	Permanent Core	20-740	626	SC
1	Ea.	Seal (fire rated conditions)	S88D Perforation Feature (head and jambs)		PE

Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including, but not limited to, additional hardware devices requirements in the above specification language, architectural plans and full specification documents).

language, architectural plans and full specification documents).

Hardware Group/Set #115

6	Ea.	Hinges	T4A3386 x NRP x security torx fasteners	630	MC
2	Ea.	Manual Flush Bolts (with dust proof strike)	FB457 x DP2 dust proof strike	630	IV
1	Ea.	Storeroom-Type Lockset	LV9080T X 06L x security torx fasteners	630	SC
1	Ea.	Permanent Core	20-740	626	SC
2	Ea.	Overhead Stop	9ADJ SERIES (-336 or size as required) x security torx fasteners	630	RX
2	Ea.	Kick Plate	8400 16" x 2" LDW x B4E x security torx fasteners	630	TR
6	Ea.	Door Silencers	SR64 or SR65 (as required)	GR	IV
1	Ea.	Astragal	Furnish and install welded, ground smooth and prime/painted astragal by door manufacturer x S77 seal		PE

Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including, but not limited to, additional hardware devices requirements in the above specification language, architectural plans and full specification documents).

Hardware Group/Set #116

—	Ea.	Hinges	T4A3386 x NRP (size and quantity per Section 08 71 00) x security torx fasteners	630	MC
1	Ea.	Storeroom-Type Lockset	L9080T X 06L x security torx fasteners	630	SC
1	Ea.	Primus I/C Cylinders (Rim or Mortise)	20-757 or 20-763 x appropriate cam x blocking rings as required (rim or mortise type and quantity as required by locking device)	626	SC
1	Ea.	Permanent Core	20-740	626	SC
1	Ea.	Closer	4040XP CUSH (installed push-side of door if door swings out) or 4040XP x REG (installed pull-side of door if door swings in) per specifications	689	LC
2	Ea.	Kick Plate	KO050 16" tall x 2" LDW (less door width) x B4E (beveled edges) x counter sunk where door allows	630	TR
1	Ea.	Door Position Switch (also known as Alarm Contact, Door Contact)	#1078D x Interlogix manufacturing (coordinate with Divisions 25-28 and applicable drawings).		
1	Ea.	Auxiliary Door Stop	#1209 x security torx fasteners	630	TR
1	Ea.	Seal (for rated or sound dampening conditions)	S88D Perforation Feature (head and jambs)		PE

Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including, but not limited to, additional hardware devices requirements in the above specification language, architectural plans and full specification documents).

Hardware Group/Set #117

—	Ea.	Hinges	T4A3386 x NRP (size and quantity per Section 08 71 00) x security torx fasteners	630	MC
1	Ea.	Institutional -Type Lockset	L9082T X 06L x security torx fasteners	630	SC
2	Ea.	Primus I/C Cylinders (Rim or Mortise)	20-757 or 20-763 x appropriate cam x blocking rings as required (rim or mortise type and quantity as required by locking device)	626	SC
2	Ea.	Permanent Core	20-740	626	SC
1	Ea.	Closer	LCN 2215 x Security Torx Fasteners	689	LC
2	Ea.	Kick Plate	KO050 16" tall x 2" LDW (less door width) x B4E (beveled edges) x counter sunk where door allows	630	TR
1	Ea.	Auxiliary Door Stop	#1209 x security torx fasteners	630	TR
1	Ea.	Seal (for rated or sound dampening conditions)	S88D Perforation Feature (head and jambs)		PE

Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including, but not limited to, additional hardware devices requirements in the above specification language, architectural plans and full specification documents).

Hardware Group/Set #118

—	Ea.	Hinges	T4A3386 x NRP (size and quantity per Section 08 71 00) x security torx fasteners	630	MC
1	Ea.	Passage Latchset	L9010 X 06L x security torx fasteners	630	SC
1	Ea.	Wall Mag Holder Device	2400L series x armature extension	689	AB
1	Ea.	Wall Mag Armature Extension	S20020 (or length as required for 90 or 180 degree swing parallel to adjacent wall)	689	AB
1	Ea.	Closer	LCN 2215 x Security Torx Fasteners	689	LC
2	Ea.	Kick Plate	KO050 16" tall x 2" LDW (less door width) x B4E (beveled edges) x counter sunk where door allows	630	TR
1	Ea.	Auxiliary Door Stop	#1209 x security torx fasteners	630	TR
1	Ea.	Seal (for rated or sound dampening conditions)	S88D Perforation Feature (head and jambs)		PE

Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including, but not limited to, additional hardware devices requirements in the above specification language, architectural plans and full specification documents).

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Glass and glazing for windows and doors.

1.2 REFERENCES

- A. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- B. Referenced Standards:
 - 1. American National Standards Institute (ANSI) – ANSI Z97.1: Standard for Safety Glazing Materials Used in Buildings.
 - 2. ASTM C920 – Standard Specification for Elastomeric Joint Sealants.
 - 3. ASTM C1036 – Standard Specification for Flat Glass.
 - 4. ASTM C1048 – Standard Specification for Heat-Treated Flat Glass – Kind HS, Kind FT Coated and Uncoated Glass.
 - 5. ASTM C1376 – Standard Specification for Pyrolytic and Vacuum Deposition Coatings on Flat Glass.
 - 6. ASTM E546 – Standard Test Method for Frost Point of Sealed Insulating Glass Units.
 - 7. ASTM E576 – Standard Test Method for Frost Point of Sealed Insulating Glass Units in the Vertical Position.
 - 8. ASTM E1300 – Standard Practice for Determining Load Resistance of Glass in Buildings.
 - 9. ASTM E2190 – Standard Specification for Insulating Glass Unit Performance and Evaluation.
 - 10. Consumer Product Safety Commission (CPSC) – CPSC 16 CFR 1201: Safety Standard for Architectural Glazing Materials.
 - 11. GANA Glazing Manual.
 - 12. GANA Sealant Manual.
 - 13. IGMA North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use.
 - 14. NFRC 100 – Procedure for Determining Fenestration Product U-Factors.
 - 15. NFRC 200 – Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence.
 - 16. NFRC 300 – Standard Test Method for Determining the Solar Optical Properties of Glazing Materials and Systems.
 - 17. SGCC – Safety Glazing Certification Council – Certified Products Directory.

1.3 SUBMITTALS

- A. Product Data on Glass Types Specified: Provide structural, physical and environmental characteristics, size limitations, and special handling or installation requirements.

- B. Product Data on Glazing Compounds: Provide chemical, functional, and environmental characteristics, limitations, and special handling or installation requirements. Identify available colors.
- C. Submit documentation indicating that all tempered glazing to be installed on this project is certified by the Safety Glazing Certification Council.
- D. Samples:
 - 1. Glass: Submit two samples, 12 inches x 12 inches in size, illustrating each type of glazing.
 - 2. Glazing Sealant: Submit 3 inch long bead of glazing sealant, color as selected by Architect.

1.4 PERFORMANCE / DESIGN CRITERIA

- A. Glass Strength: Analysis shall comply with ASTM E1300, Determining Load Resistance of Glass in Buildings. Provide glass products in the thickness and strengths (annealed or heat treated) required to meet or exceed the following criteria based on project loads and in-service conditions.
 - 1. Minimum thickness of annealed or heat-treated glass products to be selected so the worst case probability of failure does not exceed the following:
 - a. Eight breaks per thousand for glass installed vertically or not fifteen degrees or more from the vertical plane and under wind action.
 - b. One break per thousand for glass installed fifteen degrees or more from the vertical plane and under action of wind and/or snow.
 - 2. Deflection must be limited to prevent disengagement from the frame and be less than or equal to 3/4 inch or L/175.
- B. Thermal and Optical Performance: Provide glass products with performance properties specified in this Section. Performance properties shall be manufacturer's published data as determined according to the following procedures:
 - 1. Center of glass U-Value: NFRC 100 methodology using LBNL WINDOW 5.2 computer program.
 - 2. Center of glass solar heat gain coefficient: NFRC 200 methodology using LBNL-35298 WINDOW 5.2 computer program.
 - 3. Solar optical properties: NFRC 300.

1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with GANA Glazing Manual, IGMA North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use, and GANA Sealant Manual for glazing installation methods.
- B. Installer's Qualifications: The installation shall be performed only by an installation firm normally engaged in this business. All work shall be performed by qualified mechanics that specialize in glazing and glass installation.
- C. Safety glazing shall meet the requirements of 2019 CBC Section 2406 and shall be identified in accordance with 2019 CBC Sections 2403.1 and 2406.3, with identification etched in glass.
- D. Glass installation in frames shall comply with the Minimum Glazing Requirements in CBC Table 2403.2.1.

1.6 JOB AND ENVIRONMENTAL CONDITIONS

- A. Do not install glazing when ambient temperature is less than 40 degrees F.
- B. Maintain minimum ambient temperature before, during and 48 hours after installation of glazing compounds.

1.7 FIELD MEASUREMENTS

- A. Verify that field measurements are as indicated on shop Drawings.

1.8 COORDINATION

- A. Coordinate Work with glazing frames, wall openings, and adjacent Work.

1.9 WARRANTY

- A. Provide five year limited warranty from date of manufacture for insulating units that are glazed in accordance with manufacturer's glazing instructions.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All glass shall be graded and meet requirements of ASTM C1036 and ASTM C1048, Type 1, quality q3. Each light of glass delivered and installed shall have affixed thereto the manufacturer's grade label.
- B. All Low-E coated glass shall have a permanent marking affixed at the spacer identifying the coated surface.
- C. Glazing material installed in Hazardous Locations subject to human impact shall be certified and permanently labeled as meeting applicable requirements referenced in NFPA 80 and 2019 CBC Section 2406.
 - 1. CPSC 16 CFR 1201, Category I and II.

2.2 GLASS TYPES

- A. Type G-1: Low-E Insulating Glass:
 - 1. Acceptable Manufacturers:
 - a. Vitro Architectural Glass. Product: Solarban 70 (2) + Clear.
 - b. Oldcastle Glass.
 - c. Viracon.
 - d. Guardian.
 - e. Substitutions: Under provisions of Division 01.
 - 2. Material: 1 inch thick hermetically sealed assembly consisting of 1/4 inch thick Low-E clear tempered glass on the outboard surface (coating on the #2 surface), 1/2 inch air space and 1/4 inch thick clear tempered glass on the inboard surface with a Winter Daytime U-value of 0.28 or less, Solar Heat Gain Coefficient (SHGC) of 0.27 or less, and Visible Light Transmittance of 64 percent.
- B. Type G-2: Float Glass:
 - 1. Acceptable Manufacturers:
 - a. Vitro Architectural Glass.

- b. Oldcastle Glass.
 - c. Viracon.
 - d. Guardian.
 - e. Or accepted equal.
 - 2. Material: 1/2 inch thick clear tempered glass.
- C. Type G-3: Float Glass:
 - 1. Acceptable Manufacturers:
 - a. Vitro Architectural Glass.
 - b. Oldcastle Glass.
 - c. Viracon.
 - d. Guardian.
 - e. Or accepted equal.
 - 2. Material: 1/4 inch thick clear tempered glass.
- D. Type G-4: Not Used.
- E. Type G-5: See Section 08 88 13 FIRE RATED GLAZING.

2.3 GLAZING SEALANT

- A. Glazing Sealants: ASTM C920, Type S, Grade NS, Uses "G" and "A". Dow Corning 795, Tremco "Proglaze" or GE Silicone Sealants; Tremco "Mono" acrylic sealant or accepted equal. All sealants shall be compatible with the type of glazing and window frame to which they are applied.

2.4 GLAZING ACCESSORIES

- A. Setting Blocks: Neoprene EPDM blocks with a Shore A durometer hardness of 85, ± 5 percent, chemically compatible with sealant used.
- B. Spacer Shims: Neoprene, 50-60 Shore A durometer hardness, minimum 3 inches long by one half the height of the glazing stop by thickness to suit application.
- C. Glazing Tape: 100 percent solids by weight, highly adhesive and elastic, cross-linked butyl rubber preformed tape with a continuous integral EPDM shim; 57 Shore 00 durometer hardness; black color; Tremco POLYshim II Tape or accepted equal.
- D. Glazing Splines: Resilient polyvinyl chloride extruded shape to suit glazing channel retaining slot; black color.
- E. Miscellaneous: Furnish all primers-sealers, setting blocks, shims, spacers, compression seals, etc., as required for a first class workmanlike job.

2.5 FABRICATION

- A. Flat Glass:
 - 1. Comply with ASTM C1036 Standard Specification for Flat Glass, Type 1, Class 1 (clear) or Class 2 (tinted, heat-absorbing and light reducing) and Quality q3.
 - 2. ASTM C1048 Heat Treated Flat Glass, Kind HS or FT, Condition A (uncoated), or C (other coated glass).

- a. Heat Treated Flat Glass to be by horizontal (roller hearth) process with inherent rollerwave distortion parallel to the bottom edge of the glass as installed.
 - b. Maximum peak to valley rollerwave 0.003 inch in the central area and 0.008 inch within 10.5 inches of the leading and trailing edge.
 - c. Maximum bow and warp 1/32 inch per lineal foot.
 - d. All tempered architectural safety glass shall conform to ANSI Z97.1 and CPSC 16 CFR 1201.
 - e. For all fully tempered glass, provide heat soak testing conforming to EN14179 which includes a two hour dwell at 290 degrees C, ± 10 degrees C.
- B. Insulating Glass:
1. Comply with ASTM E2190 Standard Specification for Insulating Glass Unit Performance and Evaluation.
 - a. Units shall be certified for compliance by the IGCC in accordance with the above ASTM test method.
 2. The unit overall thickness tolerance shall be -1/16 inch / +1/32 inch.
 3. Comply with ASTM E546 Standard Test Method for Frost Point of Sealed Insulating Glass Units.
 4. Comply with ASTM E576 Standard Test Method for Frost Point of Sealed Insulating Glass Units in the Vertical Position.
 5. Sealed Insulating Glass Units to be double sealed with a primary seal of black polyisobutylene and a secondary seal of silicone.
 - a. The minimum thickness of the secondary seal shall be 1/16 inch.
 - b. The target width of the primary seal shall be 5/32 inch.
 - c. There shall be no voids or skips in the primary seal.
 - d. Up to a maximum of 3/32 inch of the airspace may be visible above the primary polyisobutylene sealant.
 - e. Gaps or skips between primary and secondary sealant are permitted to a maximum width of 1/16 inch by maximum length of 2 inches with gaps separated by at least 18 inches. Continuous contact between the primary seal and the secondary seal is desired.
 6. Provide a hermetically sealed and dehydrated space. Lites shall be separated by an aluminum spacer with three bent corners and one keyed-soldered corner or four bent corners and one straight butyl injected zinc plated steel straight key joint.
- C. Coated Vision Glass:
1. Comply with ASTM C1376 Standard for Pyrolytic and Vacuum Deposition Coatings on Glass.
 2. Coated products shall be magnetically sputtered vacuum deposition (MSVD).
 3. Edge Deletion: When Low-E coatings are used within an insulating unit, coating shall be edge deleted to completely seal the coating within the unit.
 - a. The edge deletion should be uniform in appearance (visually straight) and remove at least 95 percent of the coating.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify prepared openings for adequacy to receive glass.
- B. Verify that openings for glazing are correctly sized and within tolerance.
- C. Verify that surfaces of glazing channels or recesses are clean, free of obstructions, and ready to receive glazing.
- D. Report in writing any conditions that may be detrimental to the Work.

3.2 PREPARATION

- A. Clean contact surfaces with solvent and wipe dry.
- B. Seal porous glazing channels or recesses with substrate compatible primer or sealer.
- C. Check that glass is free of edge damage or face imperfections.

3.3 INSTALLATION

- A. General: Install glazing types at locations indicated on Drawings, according to glazing manufacturer's recommendations and as specified herein.
- B. Glass Glazing:
 - 1. Positioning Glass: Orient pattern and draw of glass pieces in same direction. Set all sheet glass so that any waves, etc. are horizontal.
 - 2. Do not cut, nip or abrade tempered glass.
 - 3. Watershed: Gunnable sealants, when applied as a cap head, shall form a bevel or watershed away from the glass. When tape is used to the sightline, it shall form a watershed when compressed. Do not undercut a sealant, compound, or tape below the sightline. Tool and finish sealant as required. Used tooling solution recommended by the sealant manufacturer.
 - 4. Positive Contact:
 - a. When applying a heel bead, lap onto the glass a minimum of 3/16 inch.
 - b. When applying a toe bead, whether continuous or a corner seal, make certain it is large enough to contact both the glass and sash. Install the sealant prior to glass placement.
 - 5. Setting blocks shall be 1/16 inch less than the full rabbet width, minimum length of 4 inches and high enough to provide the recommended minimum bite and edge clearance for the glass. Center blocks at 1/4 points unless otherwise recommended by the glass manufacturer.
 - 6. Provide spacer-shims at a maximum of 24 inches on center.
 - 7. Clearances: Observe minimum face clearances, edge clearance and glass bite as recommended by the glass and sealant manufacturers.
 - 8. Tape Installation: Do not install glazing tapes more than one day ahead of glass placement. Remove the paper backing from the tape only when the lite is ready

to be installed. Do not stretch the tape to make it fit. Do not overlap the ends of the tape. Instead, butt ends together, and when corners are butted together, daub with sealant to assure a positive seal.

9. Glazing tapes must be kept under proper compression.
10. Glazing stops shall be installed so that stop or frame does not bear directly against glass.
11. All glazing channels/rabbets shall be weeped so there is no standing water in contact with the insulating glass perimeter seal.

3.4 CLEANING

- A. Clean work under provisions of Division 01.
- B. Remove glazing materials from finish surfaces.
- C. Remove temporary labels after work is complete.
- D. Clean glass.

3.5 PROTECTION OF FINISHED WORK

- A. Protect finished Work under provisions of Division 01.
- B. Replacement: At completion of building construction and prior to its acceptance, all broken, cracked, excessively scratched, or otherwise imperfect glazing materials included under this Section shall be replaced with new glazing materials of the type specified, as directed by the Architect, and at no additional cost to the Owner.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Fire rated glass and glazing for windows and doors.

1.2 REFERENCES

- A. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- B. Referenced Standards:
 - 1. American National Standards Institute (ANSI) – ANSI Z97.1: Standard for Safety Glazing Materials Used in Buildings.
 - 2. ASTM C920 – Standard Specification for Elastomeric Joint Sealants.
 - 3. ASTM C1036 – Standard Specification for Flat Glass.
 - 4. ASTM C1048 – Standard Specification for Heat-Treated Flat Glass – Kind HS, Kind FT Coated and Uncoated Glass.
 - 5. ASTM E119 – Standard Test Methods for Fire Tests of Building Construction and Materials.
 - 6. ASTM E2010 – Standard Test Method for Positive Pressure Fire Tests of Window Assemblies.
 - 7. ASTM E2074 – Standard Test Method for Fire Tests of Door Assemblies, Including Positive Pressure Testing of Side-Hinged and Pivoted Swinging Door Assemblies.
 - 8. Consumer Product Safety Commission (CPSC) – CPSC 16 CFR 1201: Safety Standard for Architectural Glazing Materials.
 - 9. GANA Glazing Manual.
 - 10. GANA Sealant Manual.
 - 11. NFPA 80 – Fire Doors and Windows.
 - 12. NFPA 252 – Standard Methods of Fire Tests of Door Assemblies.
 - 13. NFPA 257 – Fire Tests of Window Assemblies.
 - 14. SGCC – Safety Glazing Certification Council – Certified Products Directory.
 - 15. UL 9 – Fire Tests of Window Assemblies.
 - 16. UL 10B – Fire Tests of Door Assemblies.
 - 17. UL 10C – Positive Pressure Fire Tests of Door Assemblies.
 - 18. UL 263 – Fire Tests of Building Construction and Materials.

1.3 SUBMITTALS

- A. Product Data on Glass Types Specified: Provide structural, physical and environmental characteristics, size limitations, and special handling or installation requirements.
- B. Product Data on Glazing Compounds: Provide chemical, functional, and environmental characteristics, limitations, and special handling or installation requirements.

- C. Samples:
 - 1. Glass: Submit two samples, 12 inches x 12 inches in size, illustrating each type of glazing.
 - 2. Glazing Sealant: Submit 3 inch long bead of glazing sealant, color as selected.

1.4 QUALITY ASSURANCE

- A. Perform Work in accordance with GANA Glazing Manual, FGMA Sealant Manual for glazing installation methods.
- B. Installer's Qualifications: The installation shall be performed only by an installation firm normally engaged in this business. All work shall be performed by qualified mechanics that specialize in glazing and glass installation.
- C. Safety glazing shall meet the requirements of 2019 CBC Section 2406 and shall be identified in accordance with 2019 CBC Sections 2403.1 and 2406.3, with identification etched in glass.
- D. Fire Protective Rated Glass:
 - 1. Fire rated glazing shall be under current follow-up service by a nationally recognized independent testing laboratory and maintain a current listing or certification. Assemblies shall be labeled in accordance with limits of listings.
 - a. Each lite shall bear permanent, non-removable label certifying it for use in tested and rated fire protective assemblies.
 - 2. Fire Protective Glazing Products for Door Assemblies: Products identical to those tested per ASTM E2074 and UL 10B, labeled and listed by UL.

1.5 DEFINITIONS

- A. Fire-Rated Glazing Assembly Identification Markings per CBC Sections 703.6 and 716.3:

Fire Test Standard	Marking	Definition of Marking
ASTM E119 or UL 263	W	Meets wall assembly criteria.
NFPA 257 or UL 9	OH	Meets fire window assembly criteria including the hose stream test.
NFPA 252 or UL 10B or UL 10C	D	Meets fire door assembly criteria
	H	Meets fire door assembly hose stream test.
	T	Meets 450 degree F temperature rise criteria for 30 minutes.
	XXX	The time in minutes of the fire resistance or fire protection rating of the glazing assembly.

1.6 JOB AND ENVIRONMENTAL CONDITIONS

- A. Do not install glazing when ambient temperature is less than 40 degrees F.
- B. Maintain minimum ambient temperature before, during and 48 hours after installation of glazing compounds.

1.7 FIELD MEASUREMENTS

- A. Verify that field measurements are as indicated on shop Drawings.

1.8 COORDINATION

- A. Coordinate Work with glazing frames, wall openings, and adjacent Work.

1.9 WARRANTY

- A. Manufacturer's Warranty: Submit, for Owner's acceptance, manufacturer's standard warranty document. Manufacturer's warranty is not intended to limit other rights that the Owner may have under the Contract Documents.
 - 1. Warranty Period: Five year warranty from date of shipping.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All glass shall be graded and meet requirements of ASTM C1036 and ASTM C1048, Type I, quality q3. Each light of glass delivered and installed shall have affixed thereto the manufacturer's grade label.
- B. Glazing material installed in Hazardous Locations, subject to human impact, shall be certified and permanently labeled as meeting applicable requirements referenced in NFPA 80.
 - 1. CPSC 16 CFR 1201, Category I and II.
 - 2. Glazing in multipurpose gymnasiums, basketball courts, and similar athletic facilities in areas subject to human impact load shall meet CPSC 16 CFR 1201, Category II or Class A of ANSI Z97.1 per CBC Section 2408.
- C. Each piece of fire-rated glazing material shall be labeled with a permanent logo including name of product, manufacturer, testing laboratory, fire rating period, and safety glazing standards.

2.2 GLASS TYPES

- A. Type G-5: Fire Resistive Rated Glass in 45 minute assemblies:
 - 1. Acceptable Manufacturers:
 - a. Safti First. Product: SuperLite II-XL 45.
 - b. Technical Glass Products (TGP).
 - c. Pilkington.
 - d. Vetrotech Saint-Gobain.
 - e. Or accepted equal.
 - 2. Material: 1 inch thick, 45 minute rated assembly consisting of inboard and outboard sheets of clear tempered glass with a fire resistive interlayer marked in accordance with CBC Sections 703.6 and 716.3. Product shall meet the requirements of ANSI Z97.1, CPSC 16 CFR 1201 Category I and II, and UL 10C.

2.3 GLAZING SEALANT

- A. Fire-Rated Glazing Tape: UL 10B and UL 10C compliant, high performance fire-rated glazing tape; Pemko FG3000 or accepted equal. Glazing tape shall be installed on both sides of frame at all vision lites in fire-rated doors. Tape shall be compatible with and acceptable for use with the type of glazing and window frame to which they are applied.

2.4 GLAZING ACCESSORIES

- A. Setting Blocks: Fire-Rated: Calcium silicate blocks, chemically compatible with sealant used.
- B. Spacer Shims: Neoprene, 50 to 60 Shore A durometer hardness, minimum 3 inches long by one half the height of the glazing stop by thickness to suit application.
- C. Glazing Tape: 100 percent solids by weight, highly adhesive and elastic, cross-linked butyl rubber preformed tape with a continuous integral EPDM shim; 57 Shore 00 durometer hardness; black color; Tremco POLYshim II Tape or accepted equal.
- D. Glazing Splines: Resilient polyvinyl chloride extruded shape to suit glazing channel retaining slot; black color.
- E. Miscellaneous: Furnish all primers-sealers, setting blocks, shims, spacers, compression seals, etc., as required for a first class workmanlike job.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify prepared openings for adequacy to receive glass.
- B. Verify that openings for glazing are correctly sized and within tolerance.
- C. Verify that surfaces of glazing channels or recesses are clean, free of obstructions, and ready to receive glazing.
- D. Report in writing any conditions that may be detrimental to the Work.

3.2 PREPARATION

- A. Clean contact surfaces with solvent and wipe dry.
- B. Seal porous glazing channels or recesses with substrate compatible primer or sealer.
- C. Check that glass is free of edge damage or face imperfections.

3.3 INSTALLATION

- A. General: Install glazing types at locations indicated on Drawings, according to glazing manufacturer's recommendations and as specified herein.
- B. Glass Glazing:
 - 1. Positioning Glass: Orient pattern and draw of glass pieces in same direction. Set all sheet glass so that any waves, etc. are horizontal.
 - 2. Do not cut, nip or abrade tempered glass.
 - 3. Watershed: Gunnable sealants, when applied as a cap head, shall form a bevel or watershed away from the glass. When tape is used to the sightline, it shall form a watershed when compressed. Do not undercut a sealant, compound, or tape below the sightline. Tool and finish sealant as required. Used tooling solution recommended by the sealant manufacturer.
 - 4. Positive Contact:
 - a. When applying a heel bead, lap onto the glass a minimum of 3/16 inch.

- b. When applying a toe bead, whether continuous or a corner seal, make certain it is large enough to contact both the glass and sash. Install the sealant prior to glass placement.
5. Setting blocks shall be 1/16 inch less than the full rabbet width, minimum length of 4 inches and high enough to provide the recommended minimum bite and edge clearance for the glass. Center blocks at 1/4 points unless otherwise recommended by the glass manufacturer.
6. Provide spacer-shims at a maximum of 24 inches on center.
7. Clearances: Observe minimum face clearances, edge clearance and glass bite as recommended by the glass and sealant manufacturers.
8. Tape Installation: Do not install glazing tapes more than one day ahead of glass placement. Remove the paper backing from the tape only when the lite is ready to be installed. Do not stretch the tape to make it fit. Do not overlap the ends of the tape. Instead, butt ends together, and when corners are butted together, daub with sealant to assure a positive seal.
9. Glazing tapes must be kept under proper compression.
10. Glazing stops shall be installed so that stop or frame does not bear directly against glass.
11. Install glazing in fire-rated assemblies to requirements of NFPA 80.
 - a. Install so that appropriate UL markings remain permanently visible.

3.4 CLEANING

- A. Remove glazing materials from finish surfaces.
- B. Remove temporary labels after work is complete.
- C. Clean glass.

3.5 PROTECTION OF FINISHED WORK

- A. Replacement: At completion of building construction and prior to its acceptance, all broken, cracked, excessively scratched, or otherwise imperfect glazing materials included under this Section shall be replaced with new glazing materials of the type specified, as directed by the Architect, and at no additional cost to the Owner.

END OF SECTION

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Continuous wall louvers.

1.2 REFERENCES

- A. Unless otherwise noted, standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes as of the date of issue of this Project Manual.
- B. Referenced Standards:
 - 1. AMCA 500-L – Laboratory Methods of Testing Louvers for Rating.

1.3 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in manufacture of AMCA certified louvers with sufficient documented experience.
- B. Louvers shall bear Air Movement and Control Association (AMCA) Certified Ratings Seals for air performance and water penetration ratings.

1.4 SUBMITTALS

- A. Submit shop drawings and product data.
- B. Indicate on shop drawings layout, elevations, dimensions and tolerances; head, jamb, and sill details; blade configuration; screening; and frames.
- C. Submit manufacturer's installation instructions.
- D. Samples: Submit two 6" x 6" samples of selected finish color.

1.5 COORDINATION

- A. Coordinate work of this Section with installation of framing, flashings, interior and exterior wall finishes and mechanical systems.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS – WALL LOUVERS

- A. Wonder Metals Corporation; Product: Model #EXSDL-6.
- B. C/S Group.
- C. AiroLite.
- D. Or accepted equal.

2.2 MATERIALS

- A. Louver blades and frame head, jamb and sill: 0.094 inch thick aluminum.

- B. Fasteners and Anchors: Stainless steel or type as recommended by manufacturer.

2.3 ACCESSORIES

- A. Flashings: Of same material as louver frame.
- B. Insect Screen and Frame: Extruded aluminum spline screen frame with 18 x 14 aluminum insect mesh, fabricated by louver manufacturer. Install on interior side of louver.

2.4 FABRICATION

- A. Louver Size: 6 inches deep, face measurements as indicated on Drawings. Nominal free area opening percentage of 60 percent, with storm-proof blades fixed at 36° angle.
- B. Louver Type: Fixed, drainable.
- C. Head and Sill Members: Roll formed to required shape, one piece per location.
- D. All welded construction.
- E. Screens: Screw to louver frame.

2.5 FINISHES

- A. Finish: Anodized

PART 3 EXECUTION

3.1 INSPECTION

- A. Verify that prepared openings and flashings are ready to receive work and opening dimensions are as indicated on shop drawings.
- B. Beginning of installation means acceptance of existing conditions.

3.2 INSTALLATION

- A. Install louver assembly in accordance with manufacturer's instructions.
- B. Install louvers level and plumb.
- C. Secure louvers in opening framing with concealed fasteners.
- D. Louver frame shall be anchored to structure with concealed fasteners appropriate for use with type of adjacent construction. Fasteners shall securely fasten louver frame to wall construction involved. Fasteners shall provide stiffness and rigidity to keep frames square, in accurate position without twisting, buckling or warping. Fasteners to framing substrate shall be the following minimums; greater as required by the louver manufacturer or as conditions warrant:
 - 1. Masonry: 1/4" diameter stainless steel wedge anchors at 24" on center with 1-1/2" minimum embedment into substrate and 2" minimum edge distance to face of substrate.
- E. Install flashings and align louver assembly to ensure moisture shed from flashings and diversion of moisture to exterior.

- F. Install insect screen on the interior face of the louver frame with mechanical fasteners.
- G. Install perimeter sealant in accordance with Section 07 92 00 "Joint Sealants".

3.3 CLEANING

- A. Clean surfaces and components per manufacturer's recommendations.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Section includes metal stud and joist framing and accessories at interior locations.

1.2 REFERENCES

- A. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- B. Referenced Standards:
 - 1. ASTM A653/A653M –Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - 2. ASTM A924/A924M –Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
 - 3. ASTM C645 –Standard Specification for Nonstructural Steel Framing Members.
 - 4. ASTM C754 –Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products.
 - 5. ASTM C1513 –Standard Specification for Steel Tapping Screws for Cold-Formed Steel Framing Connections.
 - 6. SFIA – Steel Framing Industry Association.
 - 7. SSMA – Steel Stud Manufacturers Association.
 - 8. SSPC Paint 20 – Zinc Rich Primers.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. Indicate component details, stud layout, framed openings, anchorage to structure, type and location of fasteners and accessories or items required of other related work.
 - 2. Describe method for securing studs to tracks, splicing and for blocking and reinforcement to framing connections.
- B. Product Data: Submit data describing standard framing member materials and finish, product criteria, load charts and limitations.
- C. Manufacturer's Installation Instructions: Submit special procedures, perimeter conditions requiring special attention.
- D. Evaluation Reports: For products not covered in SSMA or SFIA standards, submit manufacturer's current ICC report reviewed per the applicable building code.

1.4 SYSTEM DESCRIPTION

- A. Interior Walls and Ceilings: Metal stud and joist framing system with batt type acoustic insulation.
- B. Maximum Allowable Deflection:
 - 1. 1:120 span at gypsum board finish.
 - 2. 1:240 span at ceramic tile finishes.
- C. Wall and Ceiling Systems:
 - 1. Design to provide for movement of components without damage, failure of joint seals,

undue stress on fasteners, or other detrimental effects when subject to seasonal or cyclic day/night temperature ranges.

1.5 QUALITY ASSURANCE

- A. Framing members shall be provided by a member of the Steel Stud Manufacturer's Association (SSMA) or Steel Framing Industry Association (SFIA).
- B. Perform Work in accordance with ASTM C754.
- C. Comply with 2016 CBC, Chapter 22, Section 2211.
- D. Form, fabricate, install, and connect components in accordance with ML/SFA 540.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section.
- B. Installer: Company specializing in performing Work of this Section.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Notify manufacturer of damaged materials received. Do not install damaged materials.
- B. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.
- C. Protect cold-formed metal framing products from corrosion, deformation, and other damage during delivery, storage, and handling as required by AISI's "Code of Standard Practice".

1.8 PRE-INSTALLATION MEETING

- A. Convene minimum one week prior to commencing Work of this Section under provisions of Division 01.

1.9 COORDINATION

- A. Coordinate placement of components within stud framing system.

PART 2 PRODUCTS

2.1 METAL FRAMING SYSTEM

- A. Acceptable Manufacturers:
 - 1. ClarkDietrich Building Systems
 - 2. MarinoWARE
 - 3. CEMCO
 - 4. SCAFECO Steel Stud Company
 - 5. Or accepted equal.

2.2 COMPONENTS

- A. Framing System Components:
 - 1. 20 Gauge and Thinner: Manufactured per ASTM C645 with material meeting the

- requirements of ASTM A1003, Non-structural Grade 33 (NS33).
2. 18 Gauge: Manufactured with material meeting the requirements of ASTM A1003, Structural Grade 33, Type H (ST33H).
 3. 16 Gauge and Thicker: Manufactured with material meeting the requirements of ASTM A1003, Structural Grade 50, Type H (ST50H).
- B. Studs and Joists: ASTM A653/A653M non-load bearing rolled steel, channel shaped, punched for utility access, depths, gauges, and spacing as indicated on the Drawings.
- C. Tracks and Headers: Same material and thickness as studs.
- D. Slotted Track: Slotted track system for positive attachment of metal studs to track, for Head of Wall expansion joint movement (cyclic) and static Joint System in fire-rated construction, as detailed and required on Drawings, in compliance with UL 2079 cyclical movement $\pm 1/2$ inch overall 1 inch movement. Products: BlazeFrame DSL at rated assemblies and MaxTrak at non-rated assemblies as manufactured by ClarkDietrich Building Systems or accepted equal.
1. Forming steel shall conform to ASTM A1003, Structural Grade 33, Type H (ST33H).
 - 2.
 3. Formed steel shall be galvanized in accordance with ASTM A653 for a Class G-40 by the hot dip process.
 4. Slotted track shall be provided in standard widths and gauges, as required and indicated on Drawings. Down standing legs shall be nominally 2-1/2 inches and shall be provided with 1-1/2 inch slots at 1 inch on center.
 5. Fasteners:
 - a. For attachment of studs to slotted track, minimum No. 8 corrosion resistant by 1/2 inch waferhead screws.
 - b. For attachment of slotted track to overhead structural element, as provided for the structural details affecting the work.
- E. Furring and Bracing Members: Of same material as studs; thickness to suit purpose.
- F. Sheet Metal Backing: 16 gauge, unless noted otherwise on Drawings.
- G. Hat-Shaped, Rigid Furring Channels: ASTM C645, 7/8 inch deep.
- H. Headers and Jambs: Manufacturer's proprietary shape used to form header beams and jambs, columns, or posts of web depths indicated, unpunched, with stiffened flanges.
- I. Resilient Furring Channels: 1/2 inch deep, sheet steel members designed to reduce sound transmission.
- J. Fasteners: ASTM C1513, self-drilling, self-tapping corrosion resistant screws.
- K. Anchorage Devices: As indicated on Drawings.
- L. Touch-Up Primer for Galvanized Surfaces: SSPC-Paint 20 Type II organic zinc rich.

2.3 FINISHES

- A. Framing Members and Connections:
1. Provide galvanized finish per ASTM A653 with G-40 minimum coating weight. No equivalent coatings allowed.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify rough-in utilities are in proper location.

3.2 INSTALLATION

- A. Install metal framing per ASTM C754 and as indicated on Drawings.
- B. Align and secure top and bottom runners as indicated on Drawings.
- C. Place two beads of acoustic sealant between tracks and substrate, studs and adjacent construction, to achieve acoustic seal.
- D. Place two beads of acoustic sealant between studs and adjacent vertical surfaces to achieve acoustic seal.
- E. Framing at openings shall be as shown on Drawings. Install intermediate studs at same spacing as wall studs.
- F. Install studs vertically at 16 inches on center unless otherwise noted on Drawings.
- G. Install joists horizontally at 16 inches on center unless otherwise noted on Drawings.
- H. Align stud web openings horizontally.
- I. Secure studs to tracks as indicated on Drawings.
- J. Stud splicing not permissible.
- K. Fabricate corners using minimum of three studs.
- L. Double stud at wall openings and door and window jambs, not more than 2 inches from each side of openings.
- M. Brace stud framing system rigid.
- N. Coordinate erection of studs with requirements of door frames and window frames; install supports and attachments.
- O. Backing/Blocking: Shall be provided for all wall and ceiling finishes and for the supporting and anchorage of products, fixtures and equipment for all trades, including, but not limited to, toilet partitions, toilet room accessories, casework, mirrors, trim, applied wall finishes, artwork, wall bumpers, plumbing and electrical fixtures, etc. Coordinate size, type, and location of backing and supports with manufacturer or supplier of items requiring backing/blocking.
- P. Refer to Drawings for indication of partitions extending stud framing through ceiling to structure above. Maintain clearance under structural building members to avoid deflection transfer to studs. Install extended leg top track for slip connection.
- Q. Refer to Drawings for indication of partitions through ceiling, but not to structure above. Install diagonal stud bracing staggered at 48 inches on center to structure above. Stud bracing width and gauge shall match that of the stud framing below.

- R. Coordinate placement of insulation in stud spaces after stud frame erection.

3.3 ERECTION TOLERANCES

- A. Maximum Variation From Indicated Position: 1/8 inch in 10 feet (non-cumulative).
- B. Maximum Variation From Plumb: 1/8 inch in 10 feet (non-cumulative).

END OF SECTION

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Gypsum board wall and ceiling systems.
 2. Trim accessories, Joint compound, control joints, fasteners, reveal moldings, and sealants.
 3. Schedule - Level of Finish for gypsum board surfaces.
- B. References:
1. American Society of Testing Materials International (ASTM):
 - a. ASTM C11 - 18b: Standard Terminology Relating to Gypsum and Related Building Materials and Systems.
 - b. ASTM C475/C475M-17 Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board.
 - c. ASTM C557 - 03(2017): Standard Specification for Adhesives for Fastening Gypsum Wallboard to Wood Framing.
 - d. ASTM C631-09(2014): Standard Specification for Bonding Compounds for Interior Gypsum Plastering.
 - e. ASTM C840-19b Standard Specification for Application and Finishing of Gypsum Board.
 - f. ASTM C919 - Standard Practice for Use of Sealants in Acoustical Applications.
 - g. ASTM C1002-18 Standard Specification for Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.
 - h. ASTM C1047 - Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base.
 - i. ASTM C1177 - Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing.
 - j. ASTM C1396/C1396M-17 Standard Specification for Gypsum Board.
 - k. ASTM C1629 - Standard Classification for Abuse-Resistant Non-decorated Interior Gypsum Panel Products and Fiber-Reinforced Cement Panels.
 - l. ASTM D3273 - Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber.
 - m. ASTM D4977 - Standard Test Method for Granule Adhesion to Mineral Surfaced Roofing by Abrasion
 - n. ASTM D5420 - Standard Test Method for Impact Resistance of Flat, Rigid Plastic Specimen by Means of a Striker Impacted by a Falling Weight (Gardner Impact).
 - o. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
 - p. ASTM E695 - Standard Method for Measuring Relative Resistance of Wall, Floor, and Roof Construction to Impact Loading.
 - q. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
 - r. ASTM C 1658 - Standard Specification for Glass Mat Gypsum Panels.
 2. Gypsum Association (GA):
 - a. GA-201: Gypsum Board for Walls and Ceilings.
 - b. GA-214-2015: Recommended Levels of Finish Gypsum Board, Glass Mat & Fiber-Reinforced Gypsum Panels.
 - c. GA-214-2017: Quick Reference Guide Levels of Finish.
 - d. GA-216-2018: Application and Finishing of Gypsum Panel Products.
 - e. GA-226: Application of Gypsum Board to Curved Surfaces.
 - f. GA-235-2019: Gypsum Board Typical Mechanical and Physical Properties.

- g. GA-236: Joint Treatment under Extreme Weather Conditions.
- h. GA-238-2016: Guidelines for Prevention of Mold Growth on Gypsum Board.
- i. GA-600-2018: Fire Resistance and Sound Control Design Manual.
- j. GA-801-2017: Handling and Storage of Gypsum Panel Products.
- 3. Wall and Ceiling Bureau (WCB):
 - a. TB-52010 - Control Joints for Gypsum Board
- 4. Underwriters Laboratories UL Fire Resistance Directory (UL): Fire Resistance Volume 1 with Hourly Ratings for Beams, Floors, Roofs, Columns, Walls and Partitions.

1.2 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate with Wall Type Schedule for gypsum board systems used in conjunction with work of this Section.
- B. Preinstallation Conference: Arrange two weeks prior to beginning work of this Section.
 - 1. Walk job and determine full extent level of quality for work.

1.3 SUBMITTALS

- A. Shop Drawings
 - 1. Plan that indicates locations of control joints
- B. Product Data
 - 1. Manufacturer's published descriptive literature for gypsum board types, trim accessories, and control joints pertinent to this Section.
 - 2. Furnish manufacturer's certification indicating products comply with Contract Documents and applicable codes.
- C. Field Mock-Up to illustrate final quality.
- D. Test Data:
 - 1. Per ASTM E 119 Certified testing lab Design for each proprietary fire-resistive wall and ceiling assembly listing manufacturers and products. Unlisted manufacturers and products not accepted.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications:
 - 1. Company with minimum 5 years documented experience.
 - 2. Able to supply complete and tested systems conforming to code.
- B. Installer Qualifications:
 - 1. Company specializing in work of this section with documented experience in commercial quality work of comparable scope.
- C. Mock-Up:
 - 1. Install 8 square foot minimum mock-ups of gypsum board finish and control joints.
 - 2. Approved mock-ups may be incorporated into Work and become standard for approved workmanship and finishes.
- D. Regulatory Requirements:
 - 1. California Building Code, CCR Title 24, Part 2:
 - a. CBC– Chapter 7, Fire Resistant Materials and Construction.
 - b. CBC – Chapter 19A, Concrete.

- c. CBC – Chapter 25, Gypsum Board and Plaster.
 - 2. Fire Resistance Rated Assemblies: For fire resistance rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E119 by an independent testing agency.
 - 3. Fire Resistance Rated Assemblies: For fire resistance rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E119 by an independent testing agency.
- E. Single Source Responsibility:
- 1. Panel Products: Obtain each type of gypsum board and other panel products from single manufacturer.
 - 2. Finishing Materials: To the extent possible, obtain finishing materials from same manufacturer supplying gypsum board products. When not possible, obtain materials from manufacturer acceptable to gypsum board manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in original unbroken containers or bundles bearing name of manufacturer and brand.
- B. Verify products undamaged before acceptance at Project Site. Do not use products with visible signs of mold growth and damage.
- C. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.6 FIELD CONDITIONS

- A. Temperature, Ventilation and Moisture: Conform to GA-216 and manufacturer's instructions. Maintain temporary controls to regulate heating, ventilating, moisture, and humidity levels. Do not begin taping and finishing until following conditions are achieved.
 - 1. Building: Fully enclosed and free of standing water. Watertight roofing and wall envelope systems in place and space is not exposed to other sources of water.
 - 2. Temperature: Between 50 and 95 degrees F for minimum 48 hours.
 - 3. Gypsum Board Moisture Content: 0.4 percent on gypsum scale (12 percent on wood scale).
 - 4. Wood Substrate Moisture Content: Maximum 16 percent.
- B. Immediately remove from site gypsum board for interior use exposed to water, including gypsum board with water stains, with signs of mold, and gypsum board with mildew.
- C. Lighting: Sufficient temporary lighting to perform work to achieve specified finishes.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Georgia Pacific Corp. (GP)
- B. United States Gypsum Corp. (USG)
- C. CertainTeed Gypsum, Inc.
- D. National Gypsum

- E. Pabco Gypsum
- F. Or accepted equal.

2.2 PERFORMANCE / DESIGN CRITERIA

- A. Gypsum Board Products: Conform to general provisions of ASTM C1396.
 - 1. Ends square cut and edges tapered.
 - 2. Gypsum Board at Non-Rated Assemblies: 5/8 inch thick, type 1X
 - 3. Gypsum Board at Fire-Resistive Rated Assemblies: 5/8 inch thick, UL labeled, and conforming to ICC ES Report for Type X or Type C.
 - 4. Mold-Resistant Interior Panels: Conform to general provisions of ASTM C1658 or ASTM C1396. Test to ASTM D3273 with Rating of 10 or Test to ASTM G21 with Score of 0.
- B. Abuse-Resistant and Impact Resistant Interior Panels:
 - 1. Surface Abrasion Resistance: Test to ASTM C1629 and ASTM D4977 for maximum surface damage:
 - a. Level 1: 0.126 inch (3.2mm).
 - b. Level 2: 0.059 inch (1.5mm).
 - c. Level 3: 0.010 inch (0.3mm).
 - 2. Surface Indentation: Test to ASTM C1629 and ASTM D5420 for indentation resistance.
 - a. Level 1: 0.150 inch (3.8mm).
 - b. Level 2: 0.100 inch (2.5mm).
 - c. Level 3: 0.50 inch (1.3mm).
 - 3. Soft Body Impact: Test to ASTM C1629 and ASTM E695 until failure.
 - a. Level 1: 90 ft.-lbs. (122 J).
 - b. Level 2: 195 ft.-lbs. (265 J).
 - c. Level 3: 300 ft.-lbs. (408 J).
 - 4. Hard Body Impact: Test to ASTM C1629 until failure.
 - a. Level 1: 50 ft.-lbs. (68 J).
 - b. Level 2: 100 ft.-lbs. (136 J).
 - c. Level 3: 150 ft.-lbs. (204 J).

2.3 MATERIALS

- A. Paper Faced Gypsum Board: Conform to ASTM C1396.
 - 1. GP ToughRock.
 - 2. USG Sheetrock.
 - 3. CertainTeed Gypsum, Inc., ProRoc Gypsum Board.
 - 4. Pabco Gypsum Flame Curb.
- B. Moisture and Mold-Resistant Gypsum Board:
 - 1. GP Dens-Armor Plus, glass mat facings on front and back and moisture-resistant core.
 - 2. GP ToughRock Mold-Guard<moisture-resistant paper face.
 - 3. USG Fiberock Aqua Tough, unfaced, solid moisture-resistant core.
 - 4. USG Sheetrock Mold Tough<moisture-resistant core and paper face.
 - 5. CertainTeed Gypsum, Inc.: ProRoc Moisture and Mold Resistant with M2Tech.
 - 6. Pabco Gypsum Mold Curb.
- C. Moisture and Mold-Resistant Gypsum Board for tile baker:
 - 1. GP DensShield, fiberglass mat facings on front and back and moisture-resistant core. 5/8" thick and fire-rated where shown in the drawings

- D. Moisture, Mold, and Abuse-Resistant Gypsum Board: Tested for mold resistance in conformance to ASTM D3273 (Rating of 10) or ASTM G21 (Score of 0), and conforming to ASTM C1629 Classifications for abuse-resistance (Levels I, II, or III).
1. GP Dens-Armor Plus AbuseGuard.
 - a. Surface Abrasion: Level 3.
 - b. Indentation Resistance: Level 1.
 - c. Soft-Body Impact: Level 1.
 2. USG Sheetrock Mold Tough AR
 - a. Surface Abrasion: Level 2
 - b. Indentation Resistance: Level 2
 - c. Soft-Body Impact: Level 1
 3. USG Fiberock Aqua Tough Interior Panel.
 - a. Surface Abrasion: Level 2.
 - b. Surface Indentation: Level 2.
 - c. Soft Body Impact Test: Level 2.
 4. CertainTeed Gypsum, Inc.: ProRoc Extra Abuse Type X Gypsum Board with M2Tech.
 - a. Surface Abrasion: Level 2.
 - b. Indentation Resistance: Level 1.
 - c. Soft Body Impact: Level 3.
 - d. Hard Body Impact: Level 1.
- E. Moisture, Mold, and Impact-Resistant/Mold-Resistant Enhanced Gypsum Board: ASTM C1629 and ASTM D3273 level 10.
1. GP Dens-Armor Plus Impact-Resistant.
 - a. Surface Abrasion: Level 3 (0.126 inch abraded depth).
 - b. Surface Indentation: Level 1 (0.150 inch indentation).
 - c. Soft Body Impact: Level 3 (300 ft.-lbs.).
 - d. Hard Body Impact: Level 2 (100 ft.-lbs.).
 2. USG Fiberock Aqua Tough with Tuff Hide Primer Sealer.
 - a. Surface Abrasion: Level 3.
 - b. Surface Indentation: Level 2.
 - c. Soft Body Impact: Level 3.
 - d. Hard Body Impact: Level 2.
- F. High Impact Hard Body Impact Gypsum Board Panel: ASTM C1278. <consider as replacement for veneer plaster using surfacer, as instructed by manufacturer.
1. USG Fiberock Very High Impact (VHI).
 - a. Surface Abrasion: Level 2.
 - b. Surface Indentation: Level 2.
 - c. Soft Body Impact: Level 3.
 - d. Hard Body Impact: Level 3.

2.4 ACCESSORIES

- A. Comply with ASTM C840 and in accordance with GA-216.
1. Gypsum board sealer / masking: One Coat "Hamilton Prep Coat Plus" prior to application of gypsum board texture (sealer provided by spec section 09 90 00 Painting and Coating, masking in accordance with this section 09 29 00 Gypsum Board).
 2. Provide protective coated steel corner beads and edge trim; type designed to be concealed in finished construction by tape and joint compound.
 3. Corner Beads: Manufacturer's standard metal beads.
 4. Edge Trim: "J", "L", "LK", or "LC" casing beads – manufacturer's standard.
 5. Reinforcing Tape, Joint Compound, Adhesive, Water, Fasteners: Types recommended by system manufacturer and conforming to ASTM C475.
 - a. Typical Joint Compound: Chemical hardening type for bedding and filling, ready-mixed or powder vinyl type for topping.

6. Control Joints: Back to back casing beads.
 - a. Back control joints with 4 mil thick polyethylene air seal.

- B. Joint Treatment – ASTM C475 / C475M:
 1. Joint Tape:
 - a. Exterior Gypsum Soffit Board: USG Sheetrock Brand Paper Tape.
 - b. Glass Mat Gypsum Sheathing Board Exterior Applications: USG Sheetrock Brand Paper Tape.
 - c. Interior Gypsum Board: USG Sheetrock Brand Paper Tape.
 2. Joint Compound:
 - a. Gypsum Board – Prefilling - At open joints, rounded or beveled panel edges, and damaged surface areas, use setting type taping compound: USG Sheetrock Brand Easy Sand Setting-Type Joint Compound:
 - 1) Embedding and First Coat - For embedding tape and first coat on joints, fasteners, and trim flanges, use setting type taping compound. USG Sheetrock Brand All Purpose Joint Compound:
 - a) Use setting type compound for installing paper faced metal trim accessories: USG Sheetrock Brand All Purpose Joint Compound.
 - 2) Fill Coat: For second coat, use setting type, sandable topping compound: USG Sheetrock Brand Topping Joint Compound.
 - 3) Finish Coat: For third coat, use setting type, sandable topping compound: USG Sheetrock Brand Topping Joint Compound.
 - 4) Skim Coat: For final coat of Level 5 finish, use setting type, sandable topping compound: USG Sheetrock Brand Topping Joint Compound.
 - b. Tile Backing Panels: USG Sheetrock Brand Easy Sand Setting-Type Joint Compound.
 - c. Water Resistant Gypsum Backing Board: Use setting type taping compound and setting-type, sandable topping compound: USG Sheetrock Brand Easy Sand Setting-Type Joint Compound.
 - d. Glass Mat Sheathing Board: USG Sheetrock Brand Easy Sand Setting-Type Joint Compound.
 3. Fiberglass Tape: 2 inches wide 10 x 10 fiberglass mesh.
 - a. Reinforcing fabric: Balanced, alkali-resistant, open-weave, glass fiber fabric, made from continuous multi-end strands with tensile strength of not less than 120 lbs. and 140 lbs. in wrap and fill directions, respectively, per ASTM D1682 and complying with ASTM D578, and of 4.30 oz./sq. minimum weight.

- C. Acoustic Sealant: Serious Energy “Quiet Seal Pro”, non-hardening, gun grade sealant per ASTM C834.
 1. Or Architect Approved Substitute.

- D. Primer/Surfacer for Level 5 Finish: USG Tuff-Hide Primer-Surfacer.

- E. Acoustical Sealant at Exposed Joints: Nonsag, paintable, nonstaining, latex sealant conforming to ASTM C834. Tested to ASTM E90 for reduction of airborne sound transmission through perimeter joints and openings in building construction at representative assemblies. Specified for type and quality.

- F. Acoustical Sealant at Concealed Joints:
 1. Synthetic Rubber Joint Sealant: Single component, non-skinning, non-hardening, 90 percent solids, acoustical properties conforming to ASTM C919 and to ASTM E90.
 2. Water Based Siliconized Acrylic Latex:
 3. Install 2 beads under steel stud framing channel and wood plates and into 1/2 inch space between top of floor and bottom of gypsum board and plaster systems.

2.5 TRIM

- A. Provide trim shapes as required to cover and make neat edges.
- B. Paper Faced Metal Bead and Trim: ASTM C1047, electro-galvanized steel with paper face and flanges, USG Beadex specified for type and quality.
 - 1. Outside corner beads.
 - 2. Inside corners.
 - 3. L-type edge trims.
 - 4. J-shaped edge trim.
 - 5. 3/4 inch radius corner beads.
- C. Metal Trim Shapes: ASTM C1047.
 - 1. Galvanized steel Expanded Flange Corner Bead, L-Trim, and J-Trim.
 - 2. Galvanized one-piece L-Trim, and J-Stop.
 - 3. Zinc Control Joint No. 093.

2.6 REVEAL MOLDINGS

- A. Reveal Moldings: Aluminum 6063 T5 alloy with chemical conversion coating.
- B. 1/2 Inch F Reveal Moldings: Fry Reglet, DRMF-625-50, 5/8 inch deep by 1/2 inch wide.
- C. 3/4 Inch F Reveal Moldings: Fry Reglet, DRMF-625-75, 5/8 inch deep by 3/4 inch wide.

2.7 FASTENERS

- A. Screws conforming to ASTM C1002. Bugle or pan head, and lengths as required for securing materials in place.
 - 1. Light Gauge Metal Framing: Type S.
 - 2. 18 Gauge or Heavier Metal Framing: Type S-12.
- B. Pneumatic Fasteners:
 - 1. Minimum 0.100 inch diameter.
 - 2. Length to penetrate minimum 1/4 inch beyond steel stud framing.
 - 3. Aericote 1000 corrosion-resistant coating.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify installation conditions as satisfactory to receive work of this Section before beginning.
- B. Building Envelope: conform to following:
 - 1. Do not begin work until building envelope is fully enclosed and temperature, ventilation, and humidity are controlled.
 - 2. Do not begin work under conditions that gypsum board installation may be exposed to contact with water.

3.2 PREPARATION

- A. Protect surrounding areas and surfaces to preclude damage.
- B. Avoid soiling, spatter, and damage to work of other trades. Use cover cloths, or other means of protection. Remove, clean, and repair soiled or damaged work.

3.3 INSTALLATION

- A. Conform to ASTM C840, GA-216, and manufacturer's instructions.
- B. Corner Trim: Reinforce external corners with specified corner beads.
- C. Edge Trim: Install square edged metal trim bead at exposed edges and boundaries of areas and where abutting dissimilar materials.
- D. Reveal Trim:
 - 1. Install with screws at 12 inches on center in 10 foot lengths, except where shorter lengths are sufficient for dimension of wall plane.
 - 2. Make butt joints tight and in alignment.
 - 3. Miter corners.
 - 4. Promptly remove excess joint compound.
- E. Control Joints: Conform to WCB Tech Bulletin Control Joints and GA-234, except as otherwise indicated. Verify that required double framing is in place before installing control joints.
 - 1. Door and Other Openings: Install control joints at each side of wall opening and at both sides of wall, except alcoves and similar wall configurations.
 - 2. Continuous Wall Planes: Install control joints floor to ceiling at each 30 lineal foot of wall.
 - 3. Ceilings: Install across ceiling at each 50 lineal foot distance and each 2500 square foot of ceiling area.
 - 4. Joints with Other Materials: Install where gypsum board meets masonry, concrete, and other materials, except where joints are concealed under horizontal chair rails or other trim.
- F. Other Trim: Install as indicated or required for complete and finished installation.
- G. Panel Joints:
 - 1. Layout: Design to reduce joints to minimum.
 - 2. Install board in maximum lengths to minimize horizontal and vertical joints.
 - 3. Start installation of panels at exterior wall to position butt joints as far away from exterior wall as possible.
 - 4. Place edges in contact and fit neatly, without forcing into place.
 - 5. Stagger joints on opposite sides of partitions and on same side of wall surface at adjacent joints.
 - 6. Maintain 1/2 inch clearance from bottom of wall panel and top of floor. Seal with acoustical sealant.
 - 7. In order to prevent wicking of moisture, do not let gypsum board rest on floor after installation.
- H. Single Layer Systems: Install in accordance with ASTM C840. Where modified, amended, or required by fire resistive or sound isolation system, conform to the requirements of the manufacturer's tests, as approved.
- I. Double Layer Systems: Install in accordance with ASTM C840, including System VIII for double layer gypsum wallboard installations applied with screws. Conform to required fire resistance standards.
 - 1. Use gypsum backing board for first layer, placed parallel to framing or furring members. Use fire rated gypsum backing board for fire rated partitions. Place second layer perpendicular to first layer (unless noted otherwise within rated assembly). Offset joints of second layer from joints of first layer.

- J. Moisture and Mold Resistant Gypsum Board: Install at restrooms, kitchen, janitorial closets, and areas where moisture is present. Do not install as backer board for ceramic tile.
- K. Joint Sealant and Acoustical Sealant: Install to completely fill void between wallboard edges and adjacent surface.
- L. Plumbing, HVAC, and Electrical: Coordinate with Division 22, Division 23 and Division 26. Provide for installations and penetrations of ductwork, equipment, receptacles, and other work.

3.4 FINISHING OF GYPSUM BOARD

- A. Conform to GA-214, ASTM C840, manufacturers' instructions, and provisions of Contract Documents.
- B. Level 1: Joints and interior angles shall have tape set in joint compound. Surface shall be free of excess joint compound. Tool marks and ridges are acceptable.
- C. Level 2: Joints and interior angles shall have tape embedded in joint compound and wiped with a joint knife leaving a thin coating of joint compound over all joints and interior angles. Fastener heads and accessories shall be covered with a coat of joint compound. Surface shall be free of excess joint compound. Tool marks and ridges are acceptable.
- D. Level 3: Joints and interior angles shall have tape embedded in joint compound and one additional coat of joint compound applied over all joints and interior angles. Fastener heads and accessories shall be covered with two separate coats of joint compound. All joint compound shall be smooth and free of tool marks and ridges.
- E. Level 4: Joints and interior angles shall have tape embedded in joint compound and two separate coats of joint compound applied over all flat joints and one separate coat of joint compound applied over interior angles. Fastener heads and accessories shall be covered with three separate coats of joint compound. All joint compound shall be smooth and free of tool marks and ridges.
- F. Level 5: Joints and interior angles shall have tape embedded in joint compound and two separate coats of joint compound applied over all flat joints and one separate coat of joint compound applied over interior angles. Fastener heads and accessories shall be covered with three separate coats of joint compound. A thin skim coat of joint compound shall be applied to the entire surface. The surface shall be smooth and free of tool marks and ridges.

3.5 TRIM AND JOINT FINISHING

- A. Joints and Interior Angles: Embed tape in joint compound and apply three separate coats of joint compound over joints, angles, fastener heads, and accessories. Tool joint compound smooth and free of tool marks and ridges.
 - 1. Center reinforcing tape over joint and coat into compound leaving approximately 1/64 inch to 1/32 inch under tape to provide proper bond.
 - 2. Follow with skim coat to embed tape, but not to function as second coat.
 - 3. Allow embedding coat to thoroughly dry prior to application of second coat.
 - 4. Allow second coat to thoroughly dry.
 - 5. Apply third coat evenly over and extending beyond second coat on joints, feathering to smooth uniform finish.
- B. Beads, Trim, Fastener and Joint Depressions:
 - 1. Cover with three coats of taping and joint compound. Apply in different directions

- making smooth transitions with adjacent surfaces.
 2. Allow sufficient drying time between coats.
 3. Leave depressions flush with surface plane.
- C. Treat angles with reinforcing tape and metal trim folded to conform to adjacent surfaces for straight and true angles and edges.
- D. Allow a minimum of 24 hours' drying time between applications of compounds.
- E. Treat fastener head depressions and marred spots on surface of board with one coat of joint compound and number of coats of finishing compound as required to comply with the level of finish specified and to assure that they will be invisible after application of painted finish or wall covering.
- F. After each application of joint or finishing compound has dried, lightly sand joints.
- G. Finish surfaces shall be plumb, have straight surfaces with no waves or buckles, and shall be free of unevenness at joints. Surfaces shall be uniformly smooth and ready for painting, wall covering, or other finishes.
- H. At mechanical rooms and other areas indicated to be fire-taped, perform minimum taping and cementing of joints and fastener heads to meet applicable code requirements.
- I. Apply a skip-trowel texture finish for board at mechanical rooms and other areas indicated or scheduled. All other areas shall be finished smooth.

3.6 TOLERANCES

- A. Shim panels as necessary to conform to tolerances.
- B. Between Board Faces: 1/16 inch offset.

3.7 REPAIR

- A. After taping and finishing has been completed, and before decoration, repair all damaged and defective work, including non-decorated surfaces.
- B. Patch holes or openings 1/2 inch (13 mm) or less in diameter, or equivalent size, with a setting type finishing compound or patching plaster.
- C. Repair holes or openings over 1/2 inch (13 mm) diameter, with 16 mm (5/8 inch) thick gypsum board secured in such a manner as to provide solid substrate equivalent to undamaged surface.
- D. Remove and replace following gypsum board installations:
1. Board in contact with water for over 18 hour time period.
 2. Gypsum core exhibiting dampness or water intrusion.
 3. Facing paper exhibiting delamination.
 4. Facing or core exhibiting mold growth or turning black.
 5. Board sagging or warped.
 6. Board directly exposed to water determined to be contaminated.

3.8 PROTECTION OF FINISHED WORK

- A. Maintain temperature and humidity conditions required by manufacturer to protect the

installation.

- B. Protect completed Work from damage or deterioration until Final Acceptance of the Work.

3.9 CLEANING

- A. Clean beads, screeds, metal base, metal trim, mechanical and electrical items, and other work.
- B. Wipe clean, leaving work ready for finish specified under other Sections.
- C. As work is completed in each space, clean all rubbish, utensils, and surplus materials from the space. Leave floors broom-clean.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Ceramic tile.
- B. Setting materials including adhesives and mortar.
- C. Tile grout.
- D. Waterproofing membrane.
- E. Accessories.

1.2 REFERENCES

- A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only. Refer to Section 01 42 00 "References" for definitions, acronyms, and abbreviations.
- B. Unless otherwise noted, standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes as of the date of issue of this Project Manual.
- C. Referenced Standards and Manuals:
 - 1. ANSI A108.1A – Installation of Ceramic Tile in the Wet-Set Method, with Portland Cement Mortar.
 - 2. ANSI A108.1B – Installation of Ceramic Tile on a Cured Portland Cement Mortar Setting Bed with Dry-Set or Latex-Portland Cement Mortar.
 - 3. ANSI A108.5 – Installation of Ceramic Tile with Dry-Set Portland Cement Mortar or Latex-Portland Cement Mortar.
 - 4. ANSI A108.6 – Installation of Ceramic Tile with Chemical Resistant, Water Cleanable Tile-Setting and Grouting Epoxy.
 - 5. ANSI A108.10 – Installation of Grout in Tilework.
 - 6. ANSI A118.3 – Chemical Resistant, Water Cleanable Tile-Setting and Grouting Epoxy and Water Cleanable Tile Setting Epoxy Adhesive.
 - 7. ANSI A118.4 – Latex-Portland Cement Mortar.
 - 8. ANSI A118.10 – Load Bearing, Bonded, Waterproof Membranes for Thin-Set Ceramic Tile and Dimension Stone Installations.
 - 9. ANSI A137.1 – Ceramic Tile.
 - 10. ASTM A82 – Standard Specifications for Steel Wire, Plain, for Concrete Reinforcement.
 - 11. ASTM A185 – Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
 - 12. ASTM C144 – Standard Specification for Aggregate for Masonry Mortar.
 - 13. ASTM C150 – Standard Specification for Portland Cement.
 - 14. ASTM C373 – Standard Test Method for Water Absorption, Bulk Density, Apparent Porosity, and Apparent Specific Gravity of Fired Whiteware Products.
 - 15. ASTM C648 – Standard Test Method for Breaking Strength of Ceramic Tile.
 - 16. ASTM C1027 – Standard Test Method for Determining Visible Abrasion Resistance of Glazed Ceramic Tile.

- 17. ASTM C1028 – Standard Test Method for Determining the Static Coefficient of Friction of Ceramic Tile and Other Like Surfaces by the Horizontal Dynamometer Pull-Meter Method.
- 18. ASTM D226 – Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.
- 19. ASTM D227 – Standard Specification for Coal-Tar-Saturated Organic Felt Used in Roofing and Waterproofing.
- 20. ASTM D2103 – Standard Specification for Polyethylene Film and Sheeting.
- 21. MIA Design Manual.
- 22. TCA Handbook for Ceramic Tile Installation by Tile Council of North America, Inc.

1.3 SUBMITTALS

- A. Submit product data indicating material specifications, characteristics and instructions for using adhesives and grouts.
- B. Submit shop drawings indicating tile layout, perimeter conditions, junctions with dissimilar materials, thresholds and setting details.
- C. Samples: Submit 2 samples of each type and color of ceramic tile and trims.
- D. Closeout Submittals: Cleaning and maintenance data.

1.4 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Manufacturer Qualifications: Firm specializing in manufacturing products specified in this Section with a minimum 10 years experience.
 - 2. Installer Qualifications: Firm specializing in installing work specified in this Section acceptable to manufacturer with experience on at least 5 projects of similar nature in past 3 years.
- B. Perform work in accordance with TCA Handbook for Ceramic Tile Installation and ANSI A108 Series. Provide a copy of TCA Handbook for Ceramic Tile Installation and ANSI A108 Series at the job site.
- C. Pre-Installation Meetings:
 - 1. Convene pre-installation meeting prior to commencing work of this Section.
 - 2. Coordinate work in this Section with work in related Sections.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products in manufacturer's original containers, dry and undamaged, with seals and labels intact.
- B. Storage and Protection: Store materials in a dry secure place. Protect from weather, surface contaminants, corrosion, construction traffic, and other potential damage. Protect adhesives from freezing or overheating in accordance with manufacturer's instructions.

1.6 ENVIRONMENTAL REQUIREMENTS

- A. Perform ceramic tile work when the ambient temperature is at least 50 degrees F (10 degrees C) and rising. Maintain temperature above 50 degrees F (10 degrees C) while the work is being performed for at least 7 days after completion of the work.
- B. Do not install adhesives in a closed, unventilated environment.

1.7 WARRANTY

- A. Provide manufacturer's standard performance warranties that extend beyond a 1-year period.

1.8 MAINTENANCE

- A. Extra Materials: Provide 5 percent extra of the total square footage of each type and color of tile installed.
- B. Operations and Maintenance Data: Submit cleaning and maintenance data.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers (Ceramic Tile):
 - 1. Dal-Tile Corp.
 - 2. Kaiser Tile
 - 3. Or accepted equal.
- B. Acceptable Manufacturers (Setting Materials):
 - 1. Laticrete International, Inc., Bethany, CT; (800) 243-4788; www.laticrete.com.
 - 2. C-Cure / Omega Products International, Inc., Rancho Cordova, CA; (916) 635-3335; www.c-cure.com.
 - 3. Mapei Corp., Deerfield Beach, FL; (800) 426-2734; www.mapei.com.
 - 4. Or accepted equal.
- C. Acceptable Manufacturers (Grout):
 - 1. Laticrete International, Inc.
 - 2. C-Cure / Omega Products International, Inc.
 - 3. Or accepted equal.
- D. Acceptable Manufacturers (Waterproofing Membrane):
 - 1. The Noble Company, Grand Haven, MI; (800) 878-5788; www.noblecompany.com.
 - 2. Or accepted equal.
- E. Acceptable Manufacturers (Accessories):
 - 1. Schlüter-Systems L.P., Plattsburgh, NY; (800) 472-4588; www.schluter.com.
 - 2. Or accepted equal.
- F. Single Source Responsibility: Use setting, grout, and waterproofing materials from a single manufacturer to ensure system compatibility and quality; and to comply with manufacturer's warranty requirements.

2.2 CERAMIC TILE

- A. General: ANSI A137.1, Standard Grade. Packaging shall be grade sealed. Seals shall be marked to correspond with the marks on the signed master grade certificate.
- B. Properties:

1. Impact resistant with a minimum breaking strength of 90 lbs (40 kg) for wall tiles and 250 lbs (113 kg) for floor tiles in accordance with ASTM C648.
 2. Water absorption shall be 0.50 percent maximum in accordance with ASTM C373.
 3. Floor tiles shall have a minimum static coefficient of friction of 0.6 for walking surfaces and 0.8 for ramps in accordance with ASTM C1028.
 4. Floor tiles shall be minimum Class IV – Heavy Traffic durability when tested in accordance with ASTM C1027 for abrasion resistance as related to foot traffic.
- C. Ceramic Wall Tile:
1. Daltile, style: semi-gloss
 - a. Color: Four colors, see drawings
 - b. Size: 6" x 6"
- D. Porcelain Mosaic Floor Tile:
1. Daltile, style: Keystones
 - a. Color: one color, see drawings
 - b. Size: 2" x 2"
- E. Quarry Tile:
1. Daltile, style: Suretread
 - a. Color: two colors, see drawings
 - b. Size: 6" x 6"
 2. Or accepted equal.
- F. Special Shapes (trimmers, angles, bases, caps, stops, and returns): Same nominal size as field tile; rounded concave and convex surfaces; same properties as field tile (moisture absorption, surface finish, and color). Provide radius at all outside vertical and horizontal corner tile. Provide base at glazed wall tile.
- G. Wall Base: Unless otherwise indicated, at restrooms, and kitchen areas, wall base shall be 6 inches high with 3/8 inch minimum cove radius.

2.3 SETTING MATERIALS

- A. Latex Portland Cement Mortar: Prepackaged, one-part, high performance, latex polymer modified dry-set, thin-set mortar. Meets or exceeds ANSI A118.4.
1. Products:
 - a. Laticrete 253 Multipurpose Thin-Set Mortar.
 - b. C-Cure M-Flex Strata 914 Flexible Latex-Portland Cement Mortar.
 - c. Laticrete 253 Multipurpose Thin-Set Mortar.
 - d. Mapei Ultra/Flex 3.
 - e. Or accepted equal.
- B. Mortar Bed.

1. Materials:
 - a. Cement: Portland cement, ASTM C150 Type I.
 - b. Aggregate: ASTM C144, clean, graded, and passes a 16-mesh screen.
 - c. Hydrated Lime: ASTM C206, Type S or ASTM C207, Type S.
 - d. Water: Clean and potable.
2. Mortar Mix: Comply with ANSI A108.1A Section A-4.1a.2.

2.4 GROUTING MATERIALS

- A. Epoxy Grout: 100 percent solids epoxy grout; stainless, non-sagging, water cleanable; conforming to ANSI A118.3.
 1. Products:
 - a. SpectraLOCK™ by Laticrete International, Inc.
 - b. ColorSet Epoxy 931 by C-Cure.
 - c. Or accepted equal.
 2. Colors as selected by Architect.

2.5 MEMBRANE

- A. Waterproof Membrane: Trowel applied, liquid, or sheet membrane; load bearing; bonded; conforming to ANSI A118.10.
 1. Product:
 - a. Noble TS. Elastomeric sheet membrane composed of chlorinated polyethylene (CPE), a non-plasticized elastomer with non-woven polyester laminated to both sides.
 - b. or accepted equal.

2.6 ACCESSORIES

- A. Reinforcing Mesh: ASTM A82 and ASTM A185; galvanized welded wire fabric; 16 gage wire (1.6 mm); 2 inch by 2 inch (50 mm by 50 mm) mesh.
- B. Expansion Joint: Dilex-EZ as manufactured by Schlüter-Systems L.P., Plattsburgh, NY; (800) 472-4588; www.schluter.com, or accepted equal.
- C. Wall Outside Corner Nosings: RONDEC in stainless steel as manufactured by Schlüter-Systems L.P., Plattsburgh, NY; (800) 472-4588; www.schluter.com, or accepted equal.
- D. Elastomeric Sealants: Refer to Section 07 92 00 "Joint Sealants".

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine job site conditions and verify field dimensions. Verify substrate is plumb, level, true to line and square.
- B. Substrate surface conditions shall conform to the requirements of ANSI A108.1A and ANSI A108.1B for the type setting bed specified and for workmanship.
- C. Maximum surface variation of substrate shall not exceed maximum limits as specified in specific TCA Methods or as follows, whichever is more stringent.

Type	Walls	Floors
Latex Portland Cement Mortar	1/8 inch in 8 feet	1/8 inch in 10 feet
Mortar Bed		1/4 inch in 10 feet

- D. Tile work shall not be started until roughing in for mechanical and electrical work has been completed and tested, and built-in items requiring membrane waterproofing has been installed and tested.
- E. Report unacceptable conditions to Project Manager. Begin installation only when unacceptable conditions have been corrected.

3.2 INSTALLATION

A. General:

1. Slopes of floors shall be compliant with Title 24 and ADA for Accessibility.
2. Install in accordance with TCNA Handbook for Ceramic Tile Installation and ANSI A108.
3. Install tiles as per accepted shop drawings. Do not interrupt tile pattern through openings.
4. In areas requiring floor and wall tiles, floor tile installation shall not begin until after wall tiles have been installed.
5. Where waterproofing membrane is required, allow waterproofing membrane to cure before flood testing.
6. Cut and fit tile tight to penetrations through tile. Form corners and bases neatly. Align floor, base and wall joints.
7. Place tile joints uniform in width, subject to variance in tolerance allowed in tile size. Make joints watertight, without voids, cracks, excess mortar or excess grout.
8. Provide grout joint spacing in accordance with tile manufacturer’s recommendations.
9. Install movement joints where indicated on Drawings and as specified in this Section.
10. Sound tile after setting. Replace hollow sounding units.
11. Allow tile to set prior to grouting: Minimum of 48 hours for thin-set methods and 78 hours for mortar bed methods.

B. Installation Methods – Shower Receptor:

Method	Substrate/Application	Setting Material
TCNA Method B420 and ANSI A108.5.	Wall – Masonry w/waterproof membrane	Wall: Latex Portland Cement Mortar
Use with W2021-12	Floor – Waterproof Membrane	Floor: Mortar Bed

3.3 JOINTS

- A. Joint Widths at Floors: Install tile on floors with the following joint widths:
 1. Ceramic Mosaic Tile: 1/16 inch.
 2. Quarry Tile: 1/4 inch.
- B. Joint Widths at Walls: Install tile on walls with the following joint widths:
 1. Ceramic Mosaic Tile: 1/16 inch.
 2. Glazed Wall Tile: 1/16 inch.

3. Quarry Tile: 1/4 inch.

C. Expansion Joints:

1. Provide expansion joints at locations shown on the drawings or where drawings do not indicate location, provide in the following locations as a minimum requirement:
 - a. At control joints and expansion joints in substrate material,
 - b. Where substrate material changes to separate different materials,
 - c. Over construction joints,
 - d. Where tile abuts restraining surfaces, such as perimeter walls, curbs, and columns and at intervals of 24 to 36 feet (7.2 to 10.8 m) each way in large interior floor areas and 12 to 16 feet (3.6 to 4.8 m) in large exterior areas exposed to direct sunlight or moisture.
2. Expansion joints shall extend through setting-beds and fill.

3.4 INSTALLATION - GROUT

- A. Epoxy Grout: Install in accordance with manufacturer's printed instructions and ANSI A108.6.
1. Before grouting, ensure all tiles are firmly in place. Clean tile surfaces; remove paper and glue from face of mounted tiles. Remove spacers, strings, ropes, and pegs.
 2. Clean open tile joints. Remove excess setting materials present in the open grout joints.
 3. Mix grout in accordance with manufacturer's instructions.
 4. Apply grout firmly into open joints using a hard rubber float.
 5. Remove all excess epoxy grout from the tile surface with a rubber squeegee or rubber trowel before it loses plasticity and begins to set.
 6. Immediately perform final clean up in accordance with manufacturer's instructions.

3.5 CLEANING AND PROTECTING

- A. Clean as recommended by manufacturer. Do not use materials or methods which may damage finish surface or surrounding construction.
- B. Protect installed tile finish surfaces from damage during construction. Provide protective covering as required to ensure installed tile finish will not be damaged by work of other trades.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Suspended metal grid ceiling system.
- B. Lay-in acoustical panels.
- C. Specialty ceiling systems.
- D. Ceiling perimeter trim systems.

1.2 REFERENCES

- A. Unless otherwise noted, standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes as of the date of issue of this Project Manual.
- B. Referenced Standards:
 - 1. ASTM A641/A641M – Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.
 - 2. ASTM C635 – Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings.
 - 3. ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials.
 - 4. ASTM E1264 – Standard Classification for Acoustical Ceiling Products.
 - 5. DSA IR 25-2 – Metal Suspension Systems for Lay-in Panel Ceilings.
 - 6. UL Fire Resistance Directory and Building Material Directory.

1.3 SYSTEM DESCRIPTION

- A. Performance Requirements: Rigidly secure suspended acoustical ceiling systems, including integral mechanical and electrical components with maximum deflection of 1/360.

1.4 SUBMITTALS

- A. Product Data: Provide data on metal grid system components and acoustical units.
- B. Shop Drawings: Indicate grid layout and related dimensioning, junctions with other work or ceiling finishes, interrelations of mechanical and electrical items related to system.
- C. Samples:
 - 1. Submit two samples 6 inch by 12 inch in size illustrating material and finish of acoustical units.
 - 2. Submit two samples each, 12 inch long, of suspension system main runner, cross runner and edge trim.
- D. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.

1.5 QUALITY ASSURANCE

- A. Qualifications
 - 1. Metal Suspension Grid Manufacturer Qualifications: Firm specializing in manufacturing products specified in this Section with a minimum 10 years experience.

2. Lay-in Acoustical Tile Manufacturer Qualifications: Firm specializing in manufacturing products specified in this Section with a minimum 10 years experience.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products in manufacturer's original containers, dry and undamaged, with seals and labels intact.
- B. Storage and Protection: Store materials in a dry secure place. Protect from weather, surface contaminants, construction traffic, and other potential damage.

1.7 ENVIRONMENTAL REQUIREMENTS

- A. Maintain 60 degrees F minimum uniform temperature and 20 percent to 40 percent relative humidity prior to, during, and after installation of acoustical lay-in tiles.

1.8 SEQUENCING

- A. Sequence work to ensure acoustical ceilings are not installed until building is enclosed, sufficient heat is provided, dust-generating activities have terminated and overhead work is completed, tested and approved.
- B. Install acoustical units after interior wet work is dry.

1.9 MAINTENANCE

- A. Extra Materials:
 1. Provide 10 percent extra of each type of panel.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers – Metal Suspension System:
 1. USG Interiors, Inc.
 2. Armstrong World Industries, Inc.
 3. Chicago Metallic
 4. Or accepted equal.
- B. Acceptable Manufacturers – Lay-in Acoustical Panels:
 1. USG Interiors, Inc.
 2. Armstrong World Industries, Inc.
 3. Or accepted equal.

2.2 METAL SUSPENSION SYSTEM

- A. Metal Suspension Grid: ASTM C635, heavy duty classification; hot-dipped galvanized steel (minimum G40); 15/16 inch (24 mm) face; structural tee main and cross members; capped with steel , coated with factory applied baked-on enamel paint.

B. Products:

Suspension System	Main Runner	Cross Tees
1. USG Donn DX	DX26	DX424
2. Armstrong Prelude XL	7301	XL7342
3. Chicago Metallic Snap-Grid 200	200-01	204-01

C. Grid Finish: White.

2.3 ACCESSORIES – METAL SUSPENSION SYSTEMS

- A. Metal grid suspension system accessories as required for a complete system including but not limited to moldings, stabilizer bars, splices, hold down clips, and light fixture clips.
- B. Wire hangers: ASTM A641/A641M, zinc-coated wire, Class 1, soft temper, pre-stretched, with a yield stress of at least 3 times the design load; sizes and gages as shown on the drawings and as specified in this Section.
- C. Support channels and hangers: Galvanized primed steel (minimum G40); size and type to suit application and to meet seismic requirements and as specified in this Section.

2.4 ACOUSTICAL UNIT MATERIALS, TYPICAL SUSPENDED ACOUSTICAL CEILINGS

- A. Ultima High NRC Series manufactured by Armstrong:
 - 1. Lay-in panels: 2 feet by 2 feet by 3/4 inch panels, beveled tegular edge.
 - 2. Properties
 - a. ASTM E1264: Type IV, form 2, pattern E
 - b. ASTM E84: Class A
 - 1) Flame spread: 25
 - 2) Smoke developed: 10
 - c. Noise Reduction Coefficient (NRC): 0.75
 - d. Ceiling Attenuation Class (CAC): 35
 - e. Surface color: White
 - f. Weight: 1.08 pounds per square foot
 - g. Thermal resistance (R): 2.2
 - h. Maintenance: Can be cleaned easily with a soft brush or vacuum.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine job site conditions and verify field dimensions. Verify hangers will not interfere with other work.

3.2 INSTALLATION – SUSPENDED CEILING METAL GRID

- A. Install in accordance with CBC Section 803.9, approved shop drawings, and as specified in this Section.
- B. Install ceiling metal suspension system after major above ceiling work is complete. Coordinate location of hangers with other work.
- C. Hang suspension system independent of walls, columns, ducts, pipes and conduits.

- D. Use minimum 12 gage hanger wires for up to and including 4 feet by 4 feet grid spacing attached to main runners.
- E. Provide 12 gage hanger wires at the perimeter ends of all main and cross runners within 8 inches of the support or within 1/4 of the length of the end tee, whichever is least. End connections for runners which are designed and detailed to resist the applied vertical and horizontal forces may be used in lieu of the 12 gage hanger wires.
- F. Provide trapeze or other supplementary support members at obstructions to typical hanger spacing. Provide additional hangers, struts or braces as required at all ceiling breaks, soffits, or discontinuous areas. Where hanger wires are more than 1 in 6 out of plumb, provide counter-sloping wires.
- G. Ceiling grid members may be attached to no more than 2 adjacent walls, and at least 1/2 inch free of other walls. Where walls run diagonally to ceiling grid system runners, one end of main and cross runner should be free, and a minimum 1/2 inch clear of wall.
- H. At ceiling perimeter area, where main or cross runners are not connected to adjacent walls, provide interconnection between runners at the free end to prevent lateral spreading. A metal strut or a 16 gage wire with positive mechanical connection to the runner may be used. Interlock is not required where perpendicular distance from the wall to the first parallel runner is 12 inches or less.
- I. Provide bracing assemblies consisting of a compression strut and four 12 gage splayed bracing wires oriented 90 degrees from each other. Splayed bracing wires shall be taut and shall not exceed 45 degrees from the ceiling plane. Splices in bracing wires are not permitted. Space bracing assemblies as follows:
 - 1. Not more than 1/2 of the spacing given above from the perimeter wall and at the edge of vertical ceiling offsets.
 - 2. Suspended acoustical ceiling systems with a ceiling area of 144 sq ft or less, and fire rated suspended acoustical ceiling systems with a ceiling area of 96 square feet or less, surrounded by walls which connect directly to the structure above, do not require bracing assemblies when attached to 2 adjacent walls.
- J. Fasten hanger wires with not less than 3 tight turns. Fasten bracing wires with 4 tight turns. Make all tight turns within a distance of 1-1/2 inches. Install hanger or bracing wire anchors to the structure in a manner that the direction of the wire aligns as closely as possible to the direction of the forces acting on the wire.
- K. Separate all ceiling hanging and bracing wires at least 6 inches from all unbraced ducts, pipes, conduit, etc.
- L. When drilled-in concrete anchors or shot-in anchors are used in reinforced concrete for hanger wires, 1 out of 10 shall be tested for 200 lbs tension. When drilled-in concrete anchors are used for bracing wires, 1 out of 2 shall be field tested for 440 lbs tension. Shot-in anchors in concrete are not permitted for bracing wires. Refer to CBC Section 1916A.8 if any shot-in or drilled-in anchor fails.
 - 1. Concrete Anchorage Requirements:
 - a. Anchorage to Concrete: Conform to requirements of CBC Chapter 19, Section 1912 "Anchorage to Concrete-Strength Design."
- M. Attach all light fixtures and ceiling mounted air terminals or services to the ceiling grid runners to resist a horizontal force equal to the weight of the fixtures. Screw or approved fasteners are required.
- N. Flush or recessed light fixtures and air terminals or services, weighing less than 56 lbs, may

be supported directly on the runners of a heavy duty grid system. In addition, provide two 12 gage slack safety wires attached to the fixture at diagonal corners and anchored to the structure above. 4 feet by 4 feet light fixtures shall have slack wires at each corner.

- O. Flush or recessed light fixtures and air terminals or services, weighing 56 lbs or more shall be independently supported by not less than 4 taut 12 gage wires attached to the fixture and to the structure above. The 4 taut 12 gage wires, including their attachment to the structure above must be capable of supporting 4 times the weight of the unit.
- P. Support surface mounted light fixtures be at least 2 positive devices surrounding the ceiling runner and which are supported from the structure above be a 12 gage wire. Spring clips or clamps that connect only to the runner are not acceptable. Provide additional supports when light fixtures are 8 feet or longer.
- Q. Support pendant mounted light fixtures directly from structure above with hanger wires or cables passing through each pendant hanger and capable of supporting 4 times the weight of the fixture. A bracing assembly is required where the pendant hanger penetrates the ceiling.
- R. Do not eccentrically load suspended ceiling grid system or produce rotation of runners.
- S. Install edge molding at intersection of ceiling and vertical surfaces, using longest practical lengths. Miter corners; provide edge moldings at junctions with other interruptions.

3.3 INSTALLATION – LAY-IN CEILING TILES

- A. Install acoustical units in accordance with manufacturer's instructions.
- B. Fit acoustical units in place, free from damaged edges or other defects detrimental to appearance and function.
- C. Cut panels to fit irregular grid and perimeter edge trim. Double cut and field paint exposed edges of tegular units.
- D. Lay directional patterned units one way with pattern parallel to longest room axis. Fit border trim neatly against abutting surfaces.
- E. Install units after above ceiling work is complete.
- F. Install acoustical units level, in uniform plane, and free from twist, warp and dents.
- G. Install hold-down clips to retain panels tight to grid system within 10 feet of all exterior doors.

3.4 ERECTION TOLERANCES

- A. Maximum variation from flat and level surface: 1/8 inch in 10 feet.
- B. Variation from plumb of grid members caused by eccentric loads: 2 degrees maximum.

3.5 CLEANING

- A. Clean as recommended by manufacturer. Do not use materials or methods which may damage finish surface or surrounding construction

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Security metal plank ceilings.

1.2 REFERENCES

- A. Referenced Standards:
 - 1. ASTM A653/A653M –Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - 2. ASTM A1008/A1008M – Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
 - 3. ASTM C423 – Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
 - 4. ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials.
 - 5. ASTM F2322 – Standard Test Methods for Physical Assault on Vertical Fixed Barriers for Detention and Correctional Facilities.
 - 6. AWS D1.3 – Structural Welding Code - Sheet Steel.
 - 7. ISO 9001 – International Standards Organization – Standards for Quality Management.
 - 8. CISCA Guidelines.
- B. Abbreviations:
 - 1. DEC: Detention Equipment Contractor.
 - 2. ASTM: American Society for Testing Materials.
 - 3. AWS: American Welding Society.
 - 4. CISCA: Ceilings and Interior Systems Construction Association.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. Provide detailed drawings including: layout of ceiling systems, details of construction, gauges of metal, anchoring details, conditions at openings, installation details and methods, and other data pertinent to the installation, including illustration of sequence of installation to accomplish interlocking panels.
- B. Samples:
 - 1. Supply a 1 foot x 1 foot section of each ceiling system being supplied showing wall mounting members and panel sections.
 - 2. All samples submitted shall be of the production type and shall represent in all respects the minimum quality of work to be furnished by the manufacturer. No work represented by the samples shall be fabricated until the samples are approved, and any downgrading of quality demonstrated by the samples can be cause for rejection of the work.

1.4 QUALITY ASSURANCE

- A. Manufacturer's Qualification:
 - 1. Manufacturer shall provide evidence of having personnel and plant equipment capable of fabricating ceiling assemblies of the type specified herein. Manufacturer shall provide current documentation of the number of employees, a listing of their production equipment, and a description of their manufacturing facility.
 - 2. Manufacturers shall be ISO 9001, 2008 certified and shall be required to present their

Certificate of Registration upon request. The manufacturer's registrar shall be nationally recognized and shall provide the manufacturer with periodic factory follow up audits reaffirming the manufacturer's continuing compliance with their written quality program.

3. Manufacturer's production welders shall be qualified under AWS D1.3 and upon request shall provide copies of Welders Certifications in accordance with AWS D1.3.
 4. Manufacturers shall have a minimum of five years of experience successfully producing security ceiling systems of the types and sizes required in the contract documents. Upon request the manufacturer shall provide a list of successfully completed projects and the dates they were completed.
 5. Manufacturers shall have written test reports of their having passed the testing requirements of this Section and using their current materials and production processes.
- B. Subcontractor (DEC) qualifications:
1. Technically qualified and experienced in furnishing and installing detention security acoustical panel.
 2. Welders and tackers shall be qualified by the American Welding Society's procedure AWS D1.3.
 3. Has full time employees with a minimum of five years of experience in furnishing and installing detention equipment and detention security systems.
 4. Direct distributor or dealer for the manufacturer of detention security acoustical panel system specified or approved.
 5. Submit evidence of prior experience in the installation of metal security ceiling systems.
- C. Quality Criteria:
1. All ceiling construction shall be in accordance with construction of assemblies which meet the testing requirements of this Section.
 2. Fabrication methods and product quality shall meet standards specified herein.
 3. Job Site Check:
 - a. A ceiling panel at the job site shall be selected at random and sawed in half or otherwise taken apart as deemed necessary for verification that construction is in accordance with the requirements of this Section. The manufacturer shall include the cost of the replacement panel. If the panel construction does not conform to the requirements of this Section, the non-conforming panels shall be repaired or replaced at the manufacturer's expense.

1.5 WARRANTY

- A. All ceiling systems work shall be warranted from defects in workmanship and quality for a period of one year from project completion.

PART 2 PRODUCTS

2.1 SECURITY CEILING SYSTEMS

- A. Manufacturers:
1. Trussbilt
 2. Habersham Metal Products Company
 3. Gordon Corrections Division of Gordon, Inc.
 4. Or accepted equal.
- B. Materials:
1. Panel face sheet thicknesses shall be 12 gauge.
 2. Panel face sheets shall be made of commercial quality, level, cold-rolled steel conforming to ASTM A1008 / A1008M CS Type B and shall have a zinc coating applied by the hot-dip process conforming to ASTM A653/A653M Commercial Steel (CS),

coating designation A40. The steel shall be free of scale, pitting, coil breaks or other surface blemishes. It shall also be free of buckles, waves or any other defects caused by the use of improperly leveled sheets.

- C. Construction:
1. Double layer inter-locking plank ceiling system: Basis of Design: Trusspek
 - b. Ceiling Planks: Shall be 24 inches wide and supplied in manufacturer's standard lengths of 8 feet, 10 feet. All ceiling planks shall have factory formed inter-locking edges and shall be perforated with 0.125 in. diameter holes, staggered 0.218 inch on center for a 29 percent open area.
 - c. Wall perimeter angles: Shall be formed angles 0.094 inch minimum thickness and punched 16 inches on center for 3/8 inch diameter expansion anchors. Panels shall be secured to the wall angles using 12 gauge concealed angle clips.
 - d. Interim Tee supports: Tee supports shall be two wall mounting angles bolted back-to-back using 3/8 inch diameter – 16 bolts, 24 inches on center.
 - 1) Suspension for Tee supports shall be 3/8 inch diameter galvanized threaded rod, bolted to the above structure and the Tee support, 24 inches on center.
 - e. Fasteners: Exposed fasteners will not be allowed. Wall anchor bolts shall be 3/8 inch in diameter (Rawl 5015 or equivalent) and shall be placed 16 inches on center. Anchors for securing the wall moldings to the wall shall be furnished by the ceiling manufacturer.
 - f. Acoustical material: Flutes filled with mineral wool installation.
 - g. Lights, HVAC: All light and air units are to be sized to fit into and trim off to full panel width openings and shall be independently supported from above by the trade requiring the opening.
 - h. Finish: All components of the panel and suspension system visible from the floor side shall have a factory applied polyester powder coat paint finish. Prior to painting, all surfaces shall be cleaned of rust, oil and other impurities by receiving a multi-stage pre-treatment consisting of degrease and phosphate coating, clear water rinse and non-chromate sealer and rinse, to condition the surface of the metal to resist and inhibit corrosion and promote paint adhesion. Finish shall be applied after perforation to insure coating of the perforated holes. Panels and components shall be coated with DuPont TGIC Polyester or equal, white powder coat, applied at a minimum of 2 mils thickness (dry). Color as selected by Architect.

PART 3 EXECUTION

3.1 DELIVERY, STORAGE AND HANDLING

- A. Protect panels from damage during transit to job storage.
- B. Inspect panels upon delivery for damage. Minor damage may be repaired provided finish items are equal in respect to new work and acceptable to Architect. Otherwise, remove and replace with new material.

3.2 INSTALLATION

- A. General:
 1. Install ceiling system using the approved shop drawings and contract documents. Install using the manufacturer's installation instructions.
 2. Accurately locate partitions, holes, cut outs and verify locations with other trades.
 3. Set closures and steel supports with anchors to suit condition.
 4. Erect true and level with close fitting tolerances.
 5. Bearing at ends shall be a minimum of 1 inch.

- B. Fastenings
 - 1. Fasten supporting members to each other and to building construction as detailed or as otherwise required to provide a secure, permanent installation.
 - 2. Where fastening spacings and sizes are not shown, use spacings and sizings of bolts, screws and welds which will develop the full strength of the members before failure occurs in the fastenings.

- C. Touch-up Painting
 - 1. Immediately after installation, areas where prime or finish coat has been damaged and where welding has occurred shall be sanded smooth and touched up with same primer or finish touch up paint as applied by the manufacturer.
 - 2. Remove rust before touch up primer/paint is applied.

3.3 FIELD QUALITY CONTROL

- A. Hold a meeting with other trades to review installation procedures and workmanship with a special emphasis on unusual conditions to ensure correct installation procedures.

- B. Security panel system shall be installed in place by qualified personnel, trained and furnished by installer.

END OF SECTION

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes: Provide resilient base, and accessories as required for complete installation.

1.2 SYSTEM DESCRIPTION

- A. Performance Requirements: Provide materials tested under ASTM E648, Flooring Radiant Panel Test, with results of 0.45 watts/cm² or higher.

1.3 SUBMITTALS

- A. Product Data: Furnish manufacturer's product literature.
- B. Samples: Furnish samples of each base color and type.

1.4 PROJECT CONDITIONS

- A. Maintain minimum 70 degree F air temperature at installation area for 3 days prior to, during, and for 24 hours after installation.
- B. Store materials in area of application; allow three days for material to reach same temperature as area.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Resilient Base: Conform to FS SS-W-40, with premolded end stops and external corners; 1/8" gage; provide base at floor surfaces unless otherwise indicated.
 - 1. Type: Extruded rubber.
 - 2. Manufacturers: See Finish Schedule for Basis of Design product. Acceptable manufacturers include:
 - a. Johnsonite, Inc.
 - b. Burke
 - c. Or accepted equal.
 - 3. Base:
 - a. Johnsonite coved toe, 4".
 - 1) Provide base in 120' coils. 4' pieces are not acceptable.
 - b. Johnsonite Millwork base.
 - 2) Miter at all corners
 - 4. Colors: As selected by Architect from manufacturer's full range of available colors.
- B. Primers and Adhesives: Water-resistant nontoxic types recommended by base manufacturer for specified material and application.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Apply to walls, columns, pilasters, casework, and other permanent fixtures in rooms and areas where base is required.
 - 1. Fit joints tight and vertical; maintain minimum measurement of 18" between joints.
- B. Miter internal corners; use molded sections for external corners and exposed ends.
- C. Install base on solid backing, adhere tightly to wall and floor surfaces; fill voids along top edge of base with manufacturer's recommended adhesive filler.
- D. Scribe and fit to door frames and other obstructions.
- E. Install straight and level to variation of plus or minus 1/8" over 10'-0".

3.2 CLEAN-UP

- A. Remove excess adhesive from floor, base and wall surfaces without causing damage.
- B. Clean surfaces in accordance with manufacturer's recommendations.

END OF SECTION

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes: Epoxy flooring and Accessories necessary for complete installation.
- B. References:
 - 1. American Society for Testing and Materials (ASTM):
 - a. C-307: Test Method for Tensile Strength of Chemical-Resistant Mortars.
 - b. C-501: Test Method for Relative Resistance to Wear Unglazed Ceramic Tile by the Taber Abraser.
 - c. C-531: Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, and Monolithic Surfacing.
 - d. C-579: Test Methods for Compressive Strength of Chemical-Resistant Mortars and Monolithic Surfaces.
 - e. C-580: Test Method for Flexural Strength and Modulus of Elasticity of Chemical-Resistant Mortars, Grouts, and Monolithic Surfacing.
 - f. C-884: Test Method for Thermal Compatibility Between Concrete and an Epoxy Resin Overlay.
 - g. D-570: Water Absorption of Plastics.
 - h. D-695: Compression Properties of Rigid Plastic.
 - 2. Military Specifications (Mil. Spec.)
 - a. MIL D-3 134 F: (Impact Resistance) Section 4.7.3.
 - b. MIL D-3 134 F: (Indentation Resistance) Section 4.7.4.
 - c. MIL D-3234 F: (Resistance to Elevated Temperature) Section 4.7.5.
 - 3. ACI 301 Specifications for Structural Concrete for Buildings (most recent edition).
Committee in Concrete 403 bulletin 59-43, Bond Strength to Concrete.

1.2 DEFINITIONS

- A. Epoxy Resin Flooring specified under this section is referenced on the drawings on the Floor Finish Plans and Finish Schedule.

1.3 SYSTEM DESCRIPTION

- A. System shall be 1/8 inch textured epoxy surfacing with broadcast colored quartz to form a decorative skid-resistant surface. Surface finish shall be a clear two component UV light resistant epoxy grout and sealer.

1.4 SUBMITTALS

- A. Product Data:
 - 1. Submit 6 inch by 6 inch cured samples of flooring system indicating color combination and non-skid properties. Approved samples will be used during installation for product match.
 - 2. Certified Test: Submit two copies of suppliers/ manufacturers written certification that flooring system meets or exceeds required properties.
- B. Installation Instructions:
 - 1. Submit descriptive data and specific recommendations for mixing, application, curing including any precautions of special handling instructions required to comply with the Occupational Safety and Health Act.

- C. Shop Drawings: showing installation of cove base and termination details, and details at floor material transitions and where adjoining equipment.
 - a. Locate and provide detailing for flexible joints required for flooring in area of installation.
- D. Submit manufacturers' warranty information.
- E. Maintenance Instructions:
 - 1. Submit current copies of the flooring manufacturer's printed recommendations on maintenance methods and products.

1.5 QUALITY ASSURANCE

- A. Materials used in the floor surfacing shall be the products of a single manufacturer.
- B. Installation shall be performed by an applicator with minimum 5 years' experience in work of similar nature and scope. Installer must be approved by the manufacturer of the floor surfacing materials. The contractor shall furnish a written statement from the manufacturer that the installer is acceptable.
- C. Installer to verify locations of all flexible joints required by the provisions of this Section and by the recommendations of the related material manufacturers.
 - 1. Joint locations may or may not be shown in drawings.
 - 2. Refer to drawings required under Submittals above.
- D. Installer to keep daily log of the date of installation, room number, type, color, and method of application of product being installed. Log must be available for inspection by the Architect upon request.
- E. Contractor to have proven experience with specified system.
- F. Portable mock-up: Prior to starting application of flooring, provide full scale portable mock-up to establish acceptable quality, durability, and appearance. Mock-up size must not be less than 4 square feet.
 - 1. Acceptable mock-up to be standard of quality for installed work.
 - 2. Unacceptable installed work to be removed and replaced until acceptable. Aesthetically unacceptable but well bonded work may be overlaid or recoated per Manufacturer's instructions if thickness clearances permit.
- G. Qualifications:
 - 1. Installer: Must be acceptable to Architect, and Manufacturer.

1.6 PROJECT CONDITIONS

- A. Maintain the ambient room and the floor temperatures at 60 degrees Fahrenheit, or above, for a period extending from 72 hours before, during and after floor installation. Concrete to receive surfacing shall have cured for at least 28 days and shall have been free of water for at least 7 days.
- B. Dew Point: Substrate temperature must be minimum of 5 degrees above dew point prior to, during or up to 24 hours after application of flooring system.
- C. Illumination: Apply flooring system only where a minimum of 30 foot-candles exist when measured 3 feet from surface.

- D. Advise other trades of fixtures and fittings not to be installed until flooring is cured and protected.

1.7 PROTECTION

- A. Protect adjacent surfaces not scheduled to receive the flooring by masking, or by other means, to maintain these surfaces free of the flooring material.
- B. Provide adequate ventilation and fire protection at all mixing and placing operations. Prohibit smoking or use of spark or flame producing devices within 50 feet of any mixing or placing operation.
- C. Provide polyethylene or rubber gloves or protective creams for all workmen engaged in applying products containing epoxy.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. All materials shall be delivered to project site in original manufacturer's sealed containers including type of material, batch numbers, date of manufacture, and pertinent labels intact and legible.
- B. Store materials in dry protected area at a temperature between 60 degrees F to 80 degrees F.
- C. Follow all manufacturer's specific instructions and prudent safety practices for storage and handling.

1.9 WARRANTY

- A. Contractor to guarantee work under this Section to be free from defects of material and installation for the duration of the warranty period. Defects occurring during warranty period shall be repaired, in a manner satisfactory to the Owner and the Architect, at no additional cost to the Owner.
 - 1. Warranty Period: One (1) Year.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design: Key Resin Company "Key Quartz B-125" grouted and sealed with Key #512 two component UV light resistant epoxy.
- B. Or accepted equal.

2.2 MATERIALS

- A. Cementitious Tile Backboard
- B. Flexible Membrane for crack treatment: 100% solids flexible epoxy.
- C. Prime Coat: Two component penetrating epoxy or optional moisture vapor control epoxy system.
- D. Aggregates:
 - 1. Blended quartz sand for base.

- 2. Color coated quartz with a minimum Mohs. hardness of 6.
- E. Matrix: Matrix-epoxy/aggregate composition.
- F. Grout and Topcoat(s): Clear two component UV light resistant epoxy.

2.3 MIXING

- A. Apply ceramic granular flooring to specified physical properties.
- B. Physical Properties:
 - 1. Weight: 1.00 lbs./sq. ft. per 1/8 inch thickness.
 - 2. Compressive Strength:
 - a. ASTM C-579
 - b. 11,500 psi
 - 3. Tensile Strength:
 - a. ASTM C-307
 - b. 2,400 psi
 - 4. Flexural Strength:
 - a. ASTM C-580
 - b. 4,300 psi
 - 5. Indentation:
 - a. MIL-D-3134F Sec. 4.7.4
 - b. Withstands 2,000 psi for 30 mins. without indentation.
 - 6. Impact Resistance:
 - a. MIL-D-3134F, Sec. 4.7.3
 - b. 16 ft./lbs.; no chipping, cracking, or delamination
 - 7. Adhesive Strength to Concrete:
 - a. ACI Committee 403
 - b. 300 psi (100% concrete failure)
 - 8. Water Absorption:
 - a. ASTM-D-570
 - b. 0.10
 - 9. Abrasion Resistance:
 - a. ASTM-C-501
 - b. 32 mg. max.
 - 10. Thermal Shock Resistance:
 - a. ASTM-C-884
 - b. Passes
 - 11. Thermal Coefficient of Expansion:
 - a. ASTM-C-531
 - b. 22×10^{-6} in/ in/ °F
- C. Provide slip-resistant, cleanable textured finish. Samples to be approved by Owner and Architect.
- D. Provide 6 inch integral covered base, typically.

2.4 FINISHES

- A. Color as selected by Architect from the manufacturer's standard patterns.

PART 3 EXECUTION

3.1 PREPARATION

- A. Obtain approval of mock-up before installing flooring.
- B. Preparation of Surface:
 - 1. Inspect surfaces to receive flooring and verify that condition is smooth and free from conditions that will adversely affect execution, permanence, or quality of work.
 - a. Remove all projections, all debris detrimental to flooring system, and dirt, oil contaminates, grease, and surface coatings affecting bond.
 - 2. Notify Architect in writing prior to commencing work of any conditions deemed unsatisfactory for the installation; installation of flooring materials is understood as acceptance of the substrate as satisfactory.
 - 3. Concrete: The General Contractor shall be responsible for hiring an independent testing service to test for moisture content and moisture vapor emission rate; install no flooring over concrete until the concrete has been cured and is sufficiently dry to achieve permanent bond with flooring as determined by material manufacturer's recommended bond and moisture tests.
 - a. Effectively remove concrete laitance by steel shot blasting or other method approved by flooring manufacturer.
 - b. Concrete slab shall have an efficient puncture-resistant reinforced moisture vapor barrier 15 mils thick minimum directly under the concrete slab (for slab on grade). Do not use vapor barrier manufactured with recycled material. Testing must be done to verify that the moisture vapor emission rate of the slab does not exceed that as recommended by the manufacturer at time of installation of the flooring or at any future date. Moisture vapor emission and moisture content testing must conform to the requirements of ASTM F-1869-98 (Calcium Chloride Test) and ASTM F-2170-02 (Relative Humidity Probe Test). If test results show excessive levels of moisture content or vapor emission rate, apply manufacturer's recommended moisture vapor emission control material.
 - c. Treat cracks in concrete using manufacturer's recommended practice. Rout out crack and fill with rigid epoxy; coat with flexible membrane in accordance with manufacturer's recommendation to reduce cracking through flooring system. Refer to section 3.2.B.

3.2 INSTALLATION

- A. Install all floor materials in strict conformance with manufacturer's instructions.
- B. Route out all cracks (larger than 1/32 inch width) and fill with Key Crack Filler or other material approved by Manufacturer of floor materials. Apply Key #580 Flexible Membrane across the crack and 12 inches on either side at a spread rate of 50 square feet per gallon to achieve 30-35 mils dry. Optional membrane reinforcement: Fiberglass scrim cloth is applied (using Key #502 Primer) to top of cured membrane or by applying scrim cloth onto surface of tacky Key #580.
- C. Prime entire surface with recommended primer or moisture vapor control treatment, apply prior to installation of crack isolation membrane and also use to fill cracks. For properly prepared tile substrates, add filler powder to epoxy primer to create a slurry consistency. Flat trowel tight against tile to fill grout joints flush. Allow to cure. If grout joints are not completely flush, repeat procedure until joints are filled flush with tile surface. Subsequent grinding and/or leveling may be necessary to eliminate raised tile edges ("crowning") that may telegraph through the epoxy topping. For areas that slope to drain, add fume silica to create a paste consistency or use Key #510-CV epoxy paste.

- D. Apply epoxy binder and broadcast decorative aggregate in two applications to achieve a minimum thickness of 1/8 inch.
- E. Apply UV light resistant epoxy grout coat and topcoat(s) to provide a uniform, dense surface.
- F. Match finished work to approved samples, uniform in thickness, sheen, color, pattern and texture, and free from defects detrimental to appearance.
- G. Apply temporary protection until floor is fully cured. The General Contractor shall protect the finished floor from the time that the sub-contractor completes the work.
- H. Integral Cove Base: Where scheduled, provide integral cove base formed from flooring over tile backerboard as specified under 09 21 00 Plaster and Gypsum Board Assemblies. Optional: provide cove trim strip at top of base as recommended by flooring manufacturer and trowel material up wall to form smooth, integral transition and base 4-6 inches high unless otherwise indicated or scheduled.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. A. Modular, resilient textile carpet tile.

1.2 REFERENCES

- A. Unless otherwise noted, standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes as of the date of issue of this Project Manual.
- B. Referenced Standards:
 - 1. AATCC-134 – Electrostatic Propensity of Carpets.
 - 2. ASTM D1667 – Standard Specification for Flexible Cellular Materials-Vinyl Chloride Polymers and Copolymers (Closed-Cell Foam).
 - 3. ASTM E648 – Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source.
 - 4. ASTM E662 – Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials.
 - 5. ASTM F710 – Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring.
 - 6. Carpet & Rug Institute Publication, CRI 104, Standard for Installation Specifications of Commercial Carpet.
 - 7. Carpet & Rug Institute Publication, CRI TM-102 – Fluorochemical Finishes.

1.3 SUBMITTALS

- A. Product Data: Describe physical and performance characteristics; sizes, patterns, colors available and method of installation.
- B. Samples: Three full size samples illustrating color and pattern for each carpet material specified. Samples shall be labeled to indicate product name, weight, thickness, weave, and manufacturer's name.
- C. Manufacturer's installation instructions.
- D. Manufacturer's written Warranty.

1.4 QUALITY ASSURANCE

- A. Concrete slabs to receive tile carpeting shall conform to applicable requirements of ASTM F710.
- B. Manufacturer: Company specializing in carpet tile with sufficient documented experience.
- C. Installer: Company with sufficient documented experience, approved by manufacturer. All work shall be performed by qualified and experienced mechanics working under the supervision of an experienced supervisor.
- D. A certification provided by carpet tile manufacturer shall be furnished to County stating that register numbers on carpet tile furnished was manufactured in accordance with these specifications.

1.5 OPERATION AND MAINTENANCE DATA

- A. Submit three copies of manufacturer's operation and maintenance data for commercial installation to County in an 8-1/2 by 11 inch hard cover binder.
- B. Include maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning, vacuum cleaning, shampooing and recommended type of furniture casters and glides for use with specified carpet tile products.

1.6 REGULATORY REQUIREMENTS

- A. Carpet tile work shall conform to applicable requirements of Americans with Disabilities Act (ADA), Subsection 4.5.
 - 1. Fasten exposed edges to floor surfaces with trim along that edge.
 - 2. Carpet tile shall have a level loop, textured loop, level cut pile, or level cut/uncut pile; height (measured from bottom of tuft) not to exceed 1/2 inch.
 - 3. Carpet tile with a pile height exceeding 1/2 inch above adjoining floor surface, shall have a transition ramp between the surfaces.
- B. Carpet tile shall meet testing requirements of ANSI/ASTM E648.

1.7 JOB AND ENVIRONMENTAL CONDITIONS

- A. Store materials for three days prior to installation in area of installation to achieve temperature stability.
- B. Maintain minimum 70 degree F ambient temperature at floor level three days prior to, during, and 24 hours after installation of materials.
- C. Carpet tiles shall be delivered to job site in original mill wrappings, with each box having register number and tags attached, or register number intact.

1.8 EXTRA MATERIALS

- A. Provide full size units equal to 5 percent of the total area of carpeting, but not less than 10 sq. yards, of each type and color specified. Extra materials shall be packaged, identified, and delivered to County.

1.9 WARRANTY

- A. Special Warranty for Carpet Tiles: Manufacturer's standard form in which manufacturer agrees to repair or replace components of carpet tile installation that fail in materials or workmanship within specified warranty period.
 - 1. Warranty does not include deterioration or failure of carpet tile due to unusual traffic, failure of substrate, vandalism, or abuse.
 - 2. Failures include, but are not limited to, more than 10 percent loss of face fiber, edge raveling, snags, runs, and delamination.
 - 3. Warranty Period: Five years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 PRODUCTS AND MANUFACTURERS

- A. A. Basis-of-Design Product: Beyond the Door-Paseo by Patcraft.
 - 1. Shaw.

2. Lees.
3. Philadelphia Commercial
4. Or accepted equal.

2.2 MATERIALS

- A. Carpet Tile: Conforming to the following criteria:
1. Carpet type Modular Tile
 2. Size 24 inch by 24 inch
 3. Construction Multi-level pattern loop
 4. Fiber product EcoSolution Nylon
 5. Total thickness 0267 inches
 6. Fiber density index 3597
 7. Backing material Non-woven synthetic
 8. Tuffed weight 32 oz/4D²
 9. Dye Method 100% Solution Dyed
 10. Colors As specified by Architect
 11. Static 3.5 kv when tested under the Standard Shuffle Test 70 degrees F – 20 percent RH
 12. Flammability Passes DOC-FF-1-70 Pill Test
 13. Flooring Radiant Panel Test Meets NFPA Class 1 when tested under ASTM E-648 glue down
 14. Smoke Density NBS Smoke Chamber NFPA-258 – Less than 450 Flaming Mode

2.3 ACCESSORIES

- A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet tile manufacturer.
- B. Primers and Adhesives:
1. Primers: As recommended by carpet tile and adhesive manufacturer.
 2. Adhesives: Water-resistant, mildew-resistant, nonstaining, pressure-sensitive type to suit products and subfloor conditions indicated, that complies with flammability requirements for installed carpet tile and is recommended by carpet tile manufacturer for releasable installation.
 - a. Adhesives shall be compatible for use over the Vapor Emissions Control System.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that substrate surfaces are smooth and flat with maximum variation of 1/8 inch in 10 feet and are ready to receive work.
- B. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet tile performance. Examine carpet tile for type, color, pattern, and potential defects.
- C. Contractor shall verify that concrete floors are dry and exhibit negative alkalinity, carbonization or dusting. Contractor shall be responsible for performing the tests required below. Concrete floor surfaces shall be tested for moisture content and alkalinity at least two weeks prior to carpet installation with the building acclimated to working environment of the tenant. Prior to installation, Contractor shall provide documentation in writing of the test results to County.

- D. Carpet tile shall not be installed when the relative humidity exceeds 60 percent. Contractor shall provide dehumidifiers as required to maintain 60 percent maximum relative humidity for the duration of the carpet tile installation.
- E. Beginning of installation means acceptance of existing substrate and site conditions.

3.2 PREPARATION

- A. General: Comply with ASTM F710, CRI 104, Section 7.3, "Site Conditions; Floor Preparation," and with carpet manufacturer's written installation instructions for preparing substrates.
- B. Remove sub-floor ridges and bumps. Fill low spots, cracks, joints, holes and other defects with sub-floor filler.
- C. Apply, trowel and float filler to leave smooth, flat, hard surface. Repair all floor irregularities.
- D. Prohibit traffic until filler is cured.
- E. Vacuum floor surface.

3.3 INSTALLATION

- A. General: Comply with CRI 104, Section 14, "Carpet Modules," and with carpet tile manufacturer's written installation instructions.
- B. Installation Pattern: Install modular tile using quarter-turn technique; unless otherwise indicated on Drawings or recommended by tile manufacturer.
- C. Installation Method: As recommended in writing by carpet tile manufacturer.
- D. Maintain dye lot integrity. Do not mix dye lots in the same area.
- E. Cut and fit carpet tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet tile manufacturer.
- F. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
- G. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on finish flooring as marked on subfloor. Use nonpermanent, nonstaining marking device.
- H. Install pattern parallel to walls and borders, unless otherwise indicated on Drawings.
- I. Install edge strips at unprotected or exposed edges of carpet tile including terminations at thresholds and where carpet tile abuts a dissimilar finished floor material. Carpet tile edges shall comply with CBC Section 1124B.2 requirements.

3.4 CLEANING

- A. Remove excess adhesive from floor, base and wall surfaces without damage. Remove and dispose of all scraps, cartons and rubbish upon completion of the work. Remove all loose yarn with sharp scissors.

- B. Clean carpet tiles of all spots with proper spot remover and vacuum clean carpet tile surfaces.

3.5 PROTECTION

- A. Protect installed carpet tile to comply with CRI 104, Section 16, "Protection of Indoor Installations."
- B. Prohibit traffic from carpet tile areas for 24 hours after installation. Installer shall take necessary steps to protect carpet tile work and the work of other trades during carpet tile installation, and shall be responsible for restoration of work or property damaged by carpet tile Installer.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Fiberglass Reinforced Plastic Panels.
- B. Accessories.

1.2 SUBMITTALS

- A. shop drawings include detail dimensions and trim and panel attachment details.
- B. Provide product data on panels, trim and adhesive.
- C. Submit two samples 6" x 6" in size illustrating panel material, color, and finish.
- D. Submit two samples 6" long in size illustrating trim material, color and finish.
- E. Submit manufacturer's installation instructions.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Fiberglass Reinforced Plastic Panels (FRP):
 - 1. Marlite FR FRP panels, or accepted equal. Smooth Surface, color as selected by Architect, 4' x 8' x 3/32". Class I/A Fire Rated; Flame Spread <25; Smoke Developed <450.
 - 2. ACI Composites.
 - 3. Or accepted equal.
- B. Accessories and Adhesives: Manufacturer's standard adhesive and joinery trim system that hides each vertical joint and exposed edges.

PART 3 EXECUTION

3.1 PREPARATION

- A. All surfaces to receive FRP shall be properly prepared in strict accordance with manufacturer's specifications and as specified herein. Fill all pinholes, cracks and other surface imperfections with spackle and scrape off surface splatters and imperfections to leave substrate surfaces smooth and free of damage.
- B. All other trade work that penetrates substrate shall be completed before beginning FRP application.

3.2 APPLICATION

- A. FRP shall be installed with adhesive supplied by or recommended by the FRP manufacturer.
- B. Apply FRP panels according to manufacturer's instructions. No horizontal seams will be permitted.

- C. Install trim in longest practicable lengths. "Piecing" of trim will not be allowed.
- D. Remove excessive adhesive from surfaces immediately.
- E. Ensure positive contact of FRP to adhesive material with all wall surfaces. Remove or replace damaged or improperly applied FRP.

3.3 CLEAN-UP

- A. Upon completion of the work of this Section, remove all surplus material, and debris from the premises.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Seamless epoxy system consisting of 100 percent solids accelerated aliphatic amine cured epoxy with chopped strand fiberglass and Kevlar® reinforcement, and an integrated anti-microbial topcoat system.

1.2 REFERENCES

- A. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- B. Referenced Standards:
 - 1. ASTM C579 – Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes.
 - 2. ASTM D4263 – Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.
 - 3. ASTM D4501 – Standard Test Method for Shear Strength of Adhesive Bonds Between Rigid Substrates by the Block-Shear Method.
 - 4. ASTM E1907 – Standard Guide to Methods of Evaluating Moisture Conditions of Concrete Floors to Receive Resilient Floor Coverings.
 - 5. ASTM F710 – Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring.
 - 6. ASTM F1869 – Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Sub-floor by Using Anhydrous Calcium Chloride.
 - 7. ASTM F2170 – Standard Test Method for Determining Relative Humidity in Concrete Slabs Using in situ Probes.
 - 8. ICRI No. 03732 – Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays, CSP 1-9.

1.3 SUBMITTALS

- A. Product Data: For each product indicated, include manufacturer's technical data, application instructions, and recommendations for each product component.
- B. Shop Drawings: Provide enlarged details indication terminations at walls, door frames, pits, curbing, etc.
- C. Samples: For each resinous system required, provide, when requested, a sample applied to a rigid backing, minimum size 3 inch x 3 inch.
- D. Installer Certificates: Signed by manufacturer, certifying that installer complies with specified requirements and has documented experience with shower installations.
- E. References: Installer shall submit a list of ten projects of similar size and complexity as this project, including Owner's names and contact phone numbers. Projects must be specifically shower projects involving installing spray applied Kevlar and fiberglass stranded epoxy system with integrated flooring and cove base.
- F. Warranty: Manufacturer shall provide a specimen copy of warranty.
- G. Manufacturer's Field Services: Provide letter of manufacturer's intent to comply with the

required field services as specified in this Section.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Pre-installation Meeting: Prior to the installation of the seamless system, meeting shall be held at the project site with the manufacturer's representative, the installer, the Architect, and the Owner's representative. Record discussions and furnish a copy to each participant. Topics to be discussed shall include, but not be limited to:
1. Planned start and completion timing for each mobilization.
 2. Safety procedures.
 3. Coordination of other trades in area.
 4. Slab conditions.
 5. Slab testing results.
 6. Surface preparation.
 7. Required room temperatures.
 8. Ventilation.
 9. Step by step installation procedures.
 10. Curing time and methods.
 11. Protection of completed work.
 12. Review of performance requirements including chemical abuse, effluent temperature, type, size, and weights of vehicular and static loads.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced installer who is experienced in applying the resinous system(s) specified herein.
- B. Certifications and Warranty: Provide a letter of training certification from the manufacturer stating that the installer is approved and experienced to apply the products specified in this Section. Provide a copy of the manufacturer's warranty that covers the five-year material and labor replacement for any project failures due to product performance or its improper installation as further clarified in this Section.
- C. Manufacturer shall submit written description of installer's experience with specified material over the last five years, including job sizes and complexity. List a minimum of ten shower projects including owner's names and phone numbers. Project list shall include contractor's experience with all required surface preparation and the installation of specified or equal fiberglass reinforced spray applied seamless system including wall, ceiling and floors. Mat-layup systems are excluded. Only spray applied systems that contain fiberglass and Kevlar strands premixed into both the part A and part B epoxy material are acceptable. Strands must be sufficient to for a matrix/web of reinforcement in epoxy material. Include owner's names and phone numbers.
- D. Source Limitations: Obtain all resinous flooring materials, including waterproofing membranes, grouts, resins, curing agents, grout coats, aggregates, topcoats, patching and fill material, joint sealants, and repair materials from a single manufacturer.
- E. Manufacturer Field Services: The installer of the coating system shall include the cost of a manufacturer's field engineering person to be present throughout the duration of all aspects of the work specified in this Section as follows:
1. Material manufacturer shall be responsible for the review of the project conditions that may impact product performance before product installation, including but not limited to project climate, acceptable temperature of substrate and air, acceptable humidity levels of air, acceptable moisture content of substrates to be coated, surface preparation, and all other conditions that are necessary for optimum product performance. The manufacturer's field engineer shall document and verify that all conditions are

acceptable prior to commencement of work.

2. The manufacturer's field representative shall submit through the Contractor written approvals of the proposed coating system including manufacturer's recommended applicator, manufacturer's recommended application procedures, and manufacturer's recommended surface preparation.
3. The manufacturer shall be solely liable for any warranty claims resulting from product failure, whether caused by defective product or improper installation for a period of five years. See Warranty article of this Section for clarification.
4. The materials manufacturer's representative shall be present on site for the pre-installation site conditions evaluation, for the duration of the surface preparation and for all phases of the installation of the specified resinous coating system.

1.6 MOCKUP

- A. Apply mockups to set quality standards for materials and execution.
 1. Accepted mockups may become part of completed Work if undisturbed at the time of project completion.
 2. Apply full thickness mockups on a minimum of a 4 foot x 4 foot section of wall. Mockup location as determined by the Architect.
 3. If a cove base is to be included on the project, mockup shall include same.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Materials shall be delivered in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storage and mixing with other components.
- B. Store materials in a location to prevent deleterious effects from sunlight, moisture, excessive heat, or cold.
- C. Storage of materials shall comply with all fire and safety regulations.

1.8 PROJECT CONDITIONS

- A. Environmental Limitations: Comply with resinous flooring manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting resinous flooring application including the following:
 1. Maintain ambient air temperature between 65 degrees F and 85 degrees F.
- B. General Condition of Substrates: Prepare and clean substrates in accordance with manufacturer's written instructions for substrate indicated. Provide clean, dry, and neutral pH substrate for resinous wall application.
- C. Masonry Walls:
 1. Abrasive Blast or mechanically abrade surfaces to achieve an ICRI CSP2 or ICRI CSP3 anchor profile for coating.
 2. Pre-patch any imperfections, recessed areas, cracks, etc. with manufacturer's recommended 100 percent solids epoxy patching material to provide an even and uniform surface. All patching shall be struck smooth and be flush with the surface of the substrate.
- D. Lighting: Proper lighting is required for installation. Lighting shall simulate permanent lighting conditions during resinous wall application.
- E. Close spaces to traffic during resinous coatings application and for not less than 48 hours

after application, unless manufacturer recommends a longer period.

- F. Airborne contamination: Resinous systems shall not be applied in areas where dust or other airborne particulate matter is being generated.

1.9 WARRANTY

- A. Manufacturer shall furnish a single, written warranty covering 100 percent of the material and labor costs protecting the Owner from delamination and product failure caused by defective product or defective installation for a period of five years from date of project completion. Joint warranties between manufacturer and installer not accepted.
 - 1. Extent of warranty shall be limited to the repair or replacement of defective surfaces at no cost to the Owner including both material and installation costs associated with any repairs or replacement of defective product or defective installation. The warranty shall not include any remedy for defects caused by abuse, improper maintenance, change of use or operation, moisture migration from the back side of coating system or by normal wear, tear and usage or structural movement of building structure.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturer:
 - 1. Basis-of-Design: Prime Coat Coating Systems, Product: Samples Shower System 5135.
 - 2. Or accepted equal.

2.2 SYSTEMS

- A. Seamless Epoxy System for Showers: An integrated system for floors, walls and ceilings consisting of 100 percent solids accelerated aliphatic amine cured epoxy with chopped strand fiberglass and Kevlar® reinforcement, and an integrated anti-microbial Glaze topcoat system.
 - 1. System Characteristics/Performance Requirements:
 - a. Color and Pattern: As selected by Architect from manufacturer's full range.
 - b. Cove Base: 3/4 inch Cant-styled.
 - c. System Thickness: Walls: 60 mils minimum.
 - d. VOCs: Less than 100 g/l.
 - e. Product Composition: Wall systems shall be spray applied 100 percent solids with fiberglass and Kevlar strands premixed into both the Part A and Part B epoxy components. System shall contain fiberglass strands sufficient enough to form a reinforced matrix/web within the resin providing increased tensile strength and impact resistance and high build characteristics as specified.
 - f. Compressive Strength Minimum: 11,700 p.s.i. per ASTM D695.
 - g. Tensile Strength Minimum: 3,900 p.s.i. per ASTM D638.
 - h. Hardness minimum: 83-88 per ASTM D2240, Shore D Durometer.
 - i. Abrasion Resistance Minimum: 0.03 gm/1000 revolutions per ASTM D4060 Taber Abrader.
 - j. High or low solids solvent-based and all water-based systems not acceptable.
 - k. Mat-layup systems not acceptable.
 - l. Roller applied systems not acceptable.
 - m. Integrated Anti-microbial shall be resistant to the following: Final finish shall include integrated anti-microbial that protects against the following:
 - 1) FUNGI BACTERIA, Alternaria tenuis Aerobacter aerogenes, Alternaria brassiciola Bacillus cereus, Aspergillus clavatus Bacillus subtilis, flavus Desulfovibrio desulfuricans, niger Ecterobacter sp., oryzae Klebsiella

pneumoniae, terreus Lactobacilli sp., ustus Micrococcus sp., versicolor Proteus sp. Aureobasidium (Pullularia) pullulans Pseudomonas aeruginosa, Candida guilliermondii S. typhimurium, lipolytica S. typhosa, pelliculosa, Salmonella choleraesuis, tropicalis Shigella sp., Chaetomium globosum Staphylococcus aureus, Cladosporium resinae Staphylococcus epidermidis, Epidermophyton sp. Streptococcus faecalis, Helminthosporium, gramineum Streptococcus pyogenes, Memnoniella echinata, Mucor racemosus. ACTINOMYCETES, Myrothecium verrucaria, Streptomyces rubrircetuli, Penicillium citrinum, Streptovercillium reticulum, Penicillium islandicum, Thermoactinomyces vulgaris, expansum, funiculosum, lilacinum, luteum, piscarium, variabile, Rhizopus nigricans, Scopulariopsis brevicaulis, Spicaria violacea, Trichophyton mentagrophytes.

2. System Components: Manufacturer's standard components which are compatible with each other as follows:
 - a. Primer/Block Filler:
 - 1) Resin: 100 percent solids penetrating epoxy primer/filler.
 - 2) Product: PC 630.
 - 3) Application method: Spray, roller, or brush.
 - 4) Minimum installed thickness: 12 mils to 16 mils over CMU and other porous surfaces.
 - 5) Number of coats: One.
 - b. Fiberglass and Kevlar® Reinforced Body Coat:
 - 1) Resin: 100 percent solids Fiberglass and Kevlar® reinforced epoxy
 - 2) Product: PC 200
 - 3) Application method: 45:1 air-powered airless spray w/gravity-fed hopper
 - 4) Reinforcement: Chopped strands of fiberglass and Kevlar®
 - 5) Minimum Installed thickness: 45 mils
 - 6) Number of coats: 1
 - c. Top Coat:
 - 1) Resin: 100 percent solids Bisphenol A chemically resistant epoxy
 - 2) Product: PC 400 with PC 499 anti-microbial
 - 3) Application method: roller or spray
 - 4) Minimum installed thickness: 8-10 mils
 - 5) Antimicrobial: Integrated into topcoat
 - 6) Type: pigmented
3. 3. General Performance Requirements:
 - a. Resinous flooring and wall systems shall meet minimum published standards in accordance with manufacturer's product data sheets. Materials shall form a monolithic reinforced coating system that forms a continuous reinforced barrier without breaks in material including at interfaces of inside and outside corners and interfaces between walls and ceilings and between walls and floors.

2.3 ACCESSORY MATERIALS

- A. Patching and Fill Material: Resinous product of resinous flooring manufacturer.
- B. Joint Sealants: Formulated by resinous flooring manufacturer for type of service and joint condition indicated.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verification: Verify that all substrate and environmental conditions are in compliance with

requirements discussed during pre-installation conference.

- B. Testing Activities During Resinous Coating Application
 - 1. Material Sampling: Owner's representative may at any time and any number of times during resinous coating application direct the Owner's independent testing agency to collect material samples for testing for compliance with requirements.
 - a. Material samples will be taken, identified, sealed, and certified in presence of Installer.
 - b. Testing agency will test samples for compliance with requirements using applicable referenced testing procedures in addition to testing procedures listed in manufacturer's product data.
 - 2. If test results show applied materials do not comply with specified requirements, Installer shall correct all deficiencies of coating system in a method and manner acceptable to the manufacturer's recommendations at no cost to the Owner.

3.2 PREPARATION

- A. General: Prepare and clean substrates in accordance with manufacturer's written instructions for substrate indicated. Provide clean, dry, and neutral pH substrate for resinous wall application.
- B. Concrete Masonry Units:
 - 1. A visual inspection by the onsite manufacturer's representative is required to ensure that the substrate is acceptable to receive the specified coating. Any deficiencies shall be corrected by the Contractor. Requirements for an acceptable surface are as follows:
 - a. Mortar shall have a minimum of 28 days cure prior to coating.
 - b. Mortar joints are struck clean and filled tightly to avoid gaps or holes and to provide a neat, uniform appearance.
 - c. Removal of all mortar spatter, protruding mortar edges or any excessive mortar.
 - d. All rough edges shall be ground smooth.
 - e. Concrete masonry units shall be cleaned.
 - f. All surfaces shall be clean, dry, free of efflorescence, or other contaminants.

3.3 INSTALLATION

- A. General: Apply components of resinous coating system according to manufacturer's written instructions to produce a uniform, monolithic wearing surface at the specified thickness.
 - 1. Coordinate application of components to provide optimum adhesion of resinous floor/wall system to substrate and intercoat adhesion.
 - 2. At substrate control, isolation, and expansion joints, provide joint as necessary in resinous flooring in compliance with manufacturer's directions and engineering details for each joint type.
 - a. Apply backer rod and elastomeric joint filler into isolation or expansion joints in compliance with manufacturer's directions.
- B. Installation of System:
 - 1. Primer/Filler Coat: Mix PC 630 components with a Jiffy Mixer for a minimum of two minutes, then apply one full coat at 12 mils to 16 mils on CMU. Allow to dry tack free.
 - 2. Build Coat: Mix PC 200 fiberglass/Kevlar®-reinforced body coat with a Jiffy Mixer for a minimum of two minutes and apply to all previously primed surfaces with a 45:1 air-powered airless spray rig with gravity-fed hopper at and allow curing. Minimum thickness of 45 mils required on walls.
 - 3. Final Finish/Glaze Coat: After build coat is fully cured, abrade all surfaces to remove any exposed fiberglass and other imperfections. Mix PC 400 with PC 499 Additive and apply to all surfaces, walls, ceilings and floors at a minimum of 8 mils to wall surfaces.

- C. Manufacturer's Field Service:
 - 1. Manufacturer shall send qualified technical representative to the Project site for the following purposes:
 - a. Coordinate schedule, environmental requirements, and pre-installation work with other trades.
 - b. Advise Installer's personnel of procedures and precautions for use of system materials.
 - c. Attend testing procedures with the Architect, the Owner's Representative, and the Installer.
 - d. Observe field mockups with the Architect, the Owner's Representative, and the Installer.
 - e. Ascertain that each component of the resinous system is being installed in accordance with manufacturer's directions.
 - f. Maintain a log of environmental conditions, work procedures, testing procedures, and protection measures to be included in job site file submittal.
 - g. Manufacturer's representative shall be on site throughout the entire product installation including all of the above, all surface preparation, and product installation.

3.4 CURING

- A. Cure resinous wall components according to manufacturer's written instructions. Prevent contamination during curing processes.
 - 1. Temperatures shall be maintained at 70 degrees F to 80 degrees F.
 - 2. Water leaks shall be prevented as they will compromise epoxy components ability to set properly. Water drips may compromise or stain finishes.
 - 3. Steam or any airborne contamination will adversely affect curing.

3.5 CLEANING

- A. Work area shall be left clean with all trash, equipment, and leftovers removed.
- B. Walls shall be cleaned prior to final inspection, providing complete curing has taken place. Refer to product data sheets for curing information for each product. Generally, non-chlorinated detergents should be used for the first month after curing is complete.
- C. For optimum coating performance and cleanability, manufacturer recommends the use of liquid soaps to prevent caking on epoxy surfaces caused by bar soaps.

3.6 PROTECTION

- A. Protect system from damage and wear during construction. Comply with manufacturer's recommendations for protective materials and their method of application. Remove temporary protection prior to final inspection. Contractor work shall take extra care in protecting the system with impact resistant, and if necessary, flame resistant coverings. Remove temporary or protective material upon project completion.

END OF SECTION

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Cementitious wood fiber plank acoustical wall system.
- B. References:
 - 1. American Society of Testing Materials (ASTM):
 - a. ASTM C423 - 17 Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
 - b. ASTM D3273-16 Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber.
 - c. ASTM E84-19b Standard Test Method for Surface Burning Characteristics of Building Materials.
 - 2. California Building Code, 2019 Edition.
 - 3. ASHRAE Standard 62.1-2004, "Ventilation for Acceptable Indoor Air Quality".
 - 4. NFPA 70 National Electrical Code.
 - 5. ASCE 7 American Society of Civil Engineers, Minimum Design Loads for Buildings and Other Structures
 - 6. International Code Council-Evaluation Services:
 - a. AC 156 Acceptance Criteria for Seismic Qualification Testing of nonstructural components.
 - 7. International Code Council-Evaluation Services Report – Seismic Engineer Report.

1.2 SUBMITTALS

- A. Product Data: Submit manufacturer's technical data for each type of Tectum® Finale™ required.
- B. Samples: Minimum 6 inch by 6 inch samples.
- C. Shop Drawings: Layout and details, show locations of items that are to be coordinated.
- D. Certifications: Manufacturer's certifications that products comply with specified requirements, including laboratory reports showing compliance with specified tests and standards. For acoustical performance, products must be tested to the A, D-20, C-20, or C-40 method; each carton of material must carry an approved independent laboratory classification.

1.3 QUALITY ASSURANCE

- A. Single-Source Responsibility: Provide acoustical panel units by a single manufacturer.
- B. Fire Performance Characteristics: Identify acoustical components with appropriate markings of applicable testing and inspecting organization.
 - 1. Surface Burning Characteristics: Tested per ASTM E 84 and complying with ASTM E 1264 Classification.

1.4 DELIVERY, STORAGE & HANDLING

- A. Deliver acoustical units to project site in original, unopened packages and store them in a fully enclosed space where they will be protected against damage from moisture, direct sunlight, surface contamination, and other causes.

- B. Provide labels indicating brand name, style, size and thickness.
- C. Before installing acoustical units, permit them to reach room temperature and a stabilized moisture content.
- D. Handle acoustical units carefully to avoid chipping edges or damaged units in any way.

1.5 PROJECT/SITE CONDITIONS

- A. Environmental Requirements:
- B. Do not install panels until building is closed in and HVAC system is operational.
- C. Locate materials onsite at least 24 hours before beginning installation to allow materials to reach temperature and moisture content equilibrium.
- D. Maintain the following conditions in areas where acoustical materials are to be installed 24 hours before, during and after installation:
 - 1. Relative Humidity: Between 65 percent and 75 percent.
 - 2. Uniform Temperature: Between 55 degrees and 70 degrees F (13 - 21 deg. C).

1.6 WARRANTY

- A. Panels: Submit a written warranty executed by the manufacturer, agreeing to repair or replace panels that fail within the warranty period of 30 years from date of substitution completion. Failures include, but are not limited to the following:
 - 1. Defects in materials or factory workmanship.

1.7 MAINTENANCE

- A. Extra Materials: Deliver extra materials to Owner. Furnish extra materials described below that match products installed. Packaged with protective covering for storage and identified with appropriate labels.
 - 1. Furnish quality of full-size units equal to 5.0 percent of amount installed.

PART 2 PRODUCTS

2.1 MANUFACTURER

- A. Basis of Design: Tectum® Finale™ Custom Panels by Armstrong World Industries, Inc.
- B. Or accepted equal.

2.2 ACOUSTICAL PANELS

- A. Acoustical Panels Type:
 - 1. Surface Texture: Coarse
 - 2. Composition: Aspen wood fibers bonded with inorganic hydraulic cement
 - 3. Thickness: 1
 - 4. Edge Profile: Beveled
 - 5. Noise Reduction Coefficient (NRC): ASTM C 423 ; Mounting; A(0.40)
 - 6. Flame Spread: ASTM E 1264; Class A.
 - 7. Dimensional Stability: HumiGuard Plus

2.3 FASTENERS

- A. Screws: Security Fasteners
- B. Fasteners to be located into studs or solid backing and placed not greater than two (2) inches from panel edges. Minimum three fasteners equally spaced along twenty-four (24) inch length side of panels at edges and field where studs and backing occur.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Do not proceed with installation until all wet work such as concrete, and painting has been completed and thoroughly dried out, unless expressly permitted by manufacturer's printed recommendations.

3.2 PREPARATION

- A. Measure each wall area and establish layout of acoustical units to balance border widths at opposite edges of each wall. Avoid use of less than half width units at borders, and comply with wall layout. Coordinate panel layout with mechanical and electrical fixtures.
- B. Coordination: Furnish layouts for preset inserts, clips, and other anchors whose installation is specified in other sections.
 - 1. Furnish concrete inserts and similar devices to other trades for installation well in advance of time needed for coordination of other work.

3.3 INSTALLATION

- A. Panels in accordance manufacturer's installation instructions.
- B. Panels must be mechanically attached to approved substrate per installation instructions.
- C. For seismic installations follow the requirements of the International Building Code, ASCE 7 and ASTM E580 and in install in accordance with the authorities having jurisdiction.

3.4 ADJUSTING AND CLEANING

- A. Replace damaged and broken Panels.
- B. Clean exposed surfaces of acoustical panels, including trim, and edge moldings. Comply with manufacturer's instructions for cleaning and touch up of minor finish damage. Remove any panels that cannot be successfully cleaned and or repaired. Replace with attic stock or new product to eliminate evidence of damage.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Surface preparation.
- B. Painting schedules, including painting of all exposed surfaces, interior and exterior, except as otherwise specified or indicated.

1.2 REFERENCES

- A. Referenced Standards, Manuals and Codes:
 - 1. ASTM D523 – Standard Test Method for Specular Gloss.
 - 2. The Master Painters Institute, MPI Gloss and Sheen Levels.

1.3 QUALITY ASSURANCE

- A. Product Manufacturer: Company specializing in manufacturing quality paint and finish products with sufficient documented experience.
- B. Applicator: Company specializing in commercial painting and finishing with sufficient documented experience.
- C. Gloss Levels: Per Master Painters Institute (MPI) gloss standards “MPI Gloss and Sheen Levels,” measured in accordance with ASTM D523.

GLOSS LEVEL	DESCRIPTION	GLOSS AT 60 DEGREES ASTM D523	SHEEN AT 85 DEGREES ASTM D523
G1	A traditional matte finish – flat.	5 units, maximum	and 10 units, maximum
G2	A high side sheen flat - "a velvet-like" finish.	10 units, maximum	and 10 - 35 units
G3	A traditional "eggshell-like" finish.	10 - 25 units	and 10 - 35 units
G4	A "satin-like" finish.	20 - 35 units	and 35 units, minimum
G5	A traditional semi-gloss.	35 - 70 units	-
G6	A traditional gloss.	70 - 85 units	-
G7	A high gloss.	More than 85 units	-

1.4 REGULATORY REQUIREMENTS

- A. Conform to CBC for flame spread and smoke density requirements for finishes.
- B. Furnish certification that all paint coatings furnished for the location of the project comply with the EPA clean air act for permissible levels of volatile organic content for architectural coatings applied in California as designated by California Air Resources Board (CARB).

1.5 SUBMITTALS

- A. Provide product data on all finishing products.

- B. Submit four brush-out samples 8 inches by 10 inches in size illustrating color selected for each surface finishing product scheduled.
- C. Field Sample: Furnish sample of actual paint colors selected on portion of building item to receive paint as directed by the County, prior to beginning interior and exterior painting.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver products to site in manufacturer's original unopened, labeled containers; inspect to verify acceptance.
- B. Store and protect products from abuse and contamination.
- C. Container labeling is to include manufacturer's name, type of paint, brand name, brand code, coverage, surface preparation, drying time, cleanup, color designation and instructions for mixing and reducing.
- D. Store paint materials at minimum ambient temperature of 50 degrees F and a maximum of 90 degrees F, in well-ventilated area, unless required otherwise by manufacturer's instructions.
- E. Take precautionary measures to prevent fire hazards and spontaneous combustion.

1.7 ENVIRONMENTAL REQUIREMENTS

- A. Provide continuous ventilation and heating facilities to maintain surface and ambient temperatures above 50 degrees F for 24 hours before, during and 48 hours after application of finishes, unless required otherwise by manufacturer's instructions.
- B. Do not apply exterior coatings during rain or snow, or when relative humidity is above 50 percent, unless required otherwise by manufacturer's instructions.
- C. Minimum Application Temperatures for Latex Paints: 50 degrees F for exterior work and interior work, unless required otherwise by manufacturer's instructions.
- D. Provide lighting level of 80 foot candles measured mid-height at substrate surface.

1.8 EXTRA STOCK

- A. Provide a new and unopened five-gallon container of each type, color and sheen to County.
- B. Label each container with color, in addition to the manufacturer's label.

PART 2 PRODUCTS

2.1 PAINT SYSTEMS, GENERAL

- A. Material Compatibility:
 - 1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 - 2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.

2.2 ACCEPTABLE MANUFACTURERS – PAINT

- A. Refer to Table at the end of this Section.
- B. Or accepted equal.

2.3 ACCEPTABLE MANUFACTURERS – PRIMER SEALERS

- A. Refer to Table at the end of this Section.
- B. Or accepted equal.

2.4 MATERIALS

- A. All paint materials shall be provided from a single manufacturer unless noted otherwise in this Section.
- B. Coatings: Ready mixed. Process pigments to a soft paste consistency capable of being readily and uniformly dispersed to a homogeneous coating.
- C. Coatings: Good flow and brushing properties; capable of drying or curing free of streaks or sags.
- D. Accessory Materials: All other materials not specifically indicated but required to achieve the finishes specified, of commercial quality.

2.5 FINISHES

- A. Refer to schedule at end of Section for surface finish schedule. Refer to Drawings for color schedule.

PART 3 EXECUTION

3.1 INSPECTION

- A. Verify that surfaces are ready to receive work as instructed by the product manufacturer.
- B. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially affect proper application.
- C. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces are below the following maximums:
 - 1. Gypsum Wallboard: 18 percent.
 - 2. Concrete Masonry Units: 10 percent.
- D. Beginning of application constitutes acceptance of existing surfaces.

3.2 PREPARATION

- A. Remove electrical plates, hardware, light fixture trim, and fittings prior to preparing surfaces or painting.
- B. Correct minor defects and clean surfaces that affect work of this Section.

- C. Seal marks that may bleed through surface finishes.
- D. Impervious Surfaces: Remove mildew by scrubbing with solution of tri-sodium phosphate and bleach. Rinse with clean water and allow surface to dry.
- E. Gypsum Board Surfaces: Latex fill minor defects. Spot-prime defects after repair.
- F. Galvanized Surfaces: Remove surface contamination and oils and wash with solvent. Apply coat of etching primer, unless otherwise recommended by finish coating system manufacturer.
- G. Shop-Primed Steel Surfaces: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Clean surfaces as recommended by primer manufacturer. Prime shop-primed steel items with steel primers specified in this Section.

3.3 PROTECTION

- A. Protect elements surrounding the work of this Section from damage or disfiguration.
- B. Repair damage to other surfaces caused by work of this Section.
- C. Furnish drop cloths, shields and protective methods to prevent spray or droppings from disfiguring other surfaces.
- D. Remove empty paint containers from site.

3.4 APPLICATION

- A. Apply products in accordance with manufacturer's instructions.
 - 1. Paint mil thicknesses shall not be less than the minimums recommended by the paint manufacturers.
- B. Do not apply finishes to surfaces that are not dry.
- C. Apply each coat to uniform finish.
- D. Apply each coat of paint slightly darker than preceding coat unless otherwise approved.
- E. Sand lightly between coats to achieve required finish.
- F. Allow applied coat to dry before next coat is applied.

3.5 FINISHING MECHANICAL AND ELECTRICAL EQUIPMENT

- A. See Divisions 21 – 23 and 25 – 28 for other items requiring painting.
- B. Paint interior surfaces of air ducts and convector heating cabinets that are visible through grilles and louvers with one coat of flat black paint, to limit of sight line. Paint dampers exposed behind grilles to match face panels. Paint all new interior and exterior exposed ductwork and ductwork supports. Paint all new conduit, pipes and conduit/pipe supports in exposed interior and exterior locations.
- C. Reinstall electrical plates, hardware, light fixture trim, and fittings removed for surface preparation or painting.

- D. Do not paint factory-finished mechanical and electrical equipment.

3.6 CLEANING

- A. As Work proceeds, promptly remove paint where spilled, splashed or spattered.
- B. During progress of Work, maintain premises free of unnecessary accumulation of tools, equipment, surplus materials and debris.
- C. Collect cotton waste, cloths, and material which may constitute a fire hazard, place in closed metal containers and remove from site daily.

3.7 PAINTING SCHEDULE – EXTERIOR SURFACES

- A. Ferrous Metal
 - 1. 1st coat – Zinc Primer
 - 2. 2nd and 3rd coats – Aliphatic Urethane Semi-Glass Enamel
- B. Galvanized Metal
 - 1. 1st coat – Etch Prep
 - 2. 2nd coat – Zinc Primer
 - 3. 3rd and 4th coats – Aliphatic Urethane Semi-Gloss Enamel

3.8 PAINTING SCHEDULE – INTERIOR SURFACES

- A. Gypsum Board
 - 1st and 2nd coats – PVA Primer Sealer
 - 3rd and 4th coats – Latex Semi-Gloss Enamel
 - Typical paint system at toilet rooms, storage rooms, kitchen.
- B. Gypsum Board
 - 1st and 2nd coats – PVA Primer Sealer
 - 3rd and 4th coats – Latex Eggshell Enamel
- C. Metal
 - 1st coat – Zinc Primer
 - 2nd and 3rd coats – Latex Semi-Gloss Enamel
 - Typical paint system at all hollow metal doors and frames.
- D. Masonry (CMU)
 - 1st coat – Acrylic Block Filler Primer
 - 2nd and 3rd coats – Waterborne Semi-Gloss Epoxy Paint
- E. Galvanized Metal, Zinc Alloy Metal and Aluminum
 - 1st coat – Etch Prep
 - 2nd coat – Zinc Primer
 - 3rd and 4th coats – Latex Semigloss Enamel

APPLICATION	TYPE	MPI Gloss Level	Dunn Edwards	Glidden Professio nal/Devo e	Sherwin Williams	Kelly Moore	TNEME C
PRIMERS							
Exterior Ferrous Metal	Zinc	G1					90-97
Exterior Galvanized Metal	Zinc	G1					90-97
Interior Masonry (Block Filler)	Acrylic	G1	W315	4000	B25W25	521	
Interior Gypsum Board	PVA	G1	W101	1030	B28W400	971	
Interior Ferrous Metal	Zinc	G1					18
Interior Galvanized Metal	Zinc	G1					18
FINISHES							
Exterior Ferrous and Galvanized Metal	Aliphatic Urethane Enamel	G6	Carbotha ne 134MC	379	B65 Series	-	
Interior Gypsum Board, Ferrous Metal, and Galvanized Metal	Latex Enamel	G5	SPMA50	1406	B31W251	1650	
Interior Gypsum Board	Latex Enamel	G3	SPMA30	1402	B20W251	1686	
Interior Masonry	Waterborne Epoxy	G5		WB4406	B70W211 and B60V25	7100	
MISCELLANEOUS							
Exterior Heavy Duty Cleaner	Water- Based	N/A		88		Jasco Prep & Prime	
Exterior & Interior Galvanized Metal Etch Prep	N/A	N/A					

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Liquid Chalk Writing Surfaces.
- B. Tackboards.
- C. Trim, marker tray and accessories.

1.2 REFERENCES

- A. Unless otherwise noted, standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes as of the date of issue of this Project Manual.
- B. Referenced Standards:
 - 1. AA – Designation System for Aluminum Finishes.
 - 2. ASTM B221 – Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
 - 3. ASTM C1396/C1396M – Standard Specification for Gypsum Wallboard.
 - 4. ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials.
 - 5. Porcelain Enamel Institute – Performance Specifications for Porcelain Enamel Chalkboards.

1.3 SUBMITTALS

- A. Shop drawings including wall elevations, dimensions, joint locations, special anchorage details. Method of attachment to structure shall be approved by Architect.
- B. Provide product data on markerboards, tackboards, trim and accessories.
- C. Submit two samples 4" x 4" in size illustrating markerboard and tackboard materials, finish, color, and texture.
- D. Submit manufacturer's installation instructions.

1.4 REGULATORY REQUIREMENTS

- A. Conform to flame and smoke rating for markerboards and vinyl fabric covered tackboards in accordance with ASTM E84.

1.5 MAINTENANCE DATA

- A. Include maintenance information on regular cleaning and stain removal.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Claridge Products and Equipment, Products:
- B. PolyVision Corporation.

- C. ADP Lemco, Inc.
- D. Or accepted equal.

2.2 MATERIALS

- A. Markerboards, Basis of Design: Claridge Booseries.
 - 1. Outer Face Sheet Steel: 24 gage steel with LCS (porcelain enamel) face.
 - 2. Aluminum Extrusions: ASTM B221, 6063 alloy, T-5 temper.
 - a. Frame: 5/8 » Face, mitered corners, concealed fasteners.
 - b. Chalk Tray: Manufacturer's standard profile; one piece, full length of markerboard with end closures; concealed fasteners.
 - c. Map Rail: Continuous 1" map rail with cork insert and end stops at each end of markerboard.
 - 3. Hardboard Core: 3/8" thick particle board; tempered, smooth face.
 - 4. Foil Backing: Aluminum foil sheet, 0.005" thick.
 - 5. Adhesives: Type recommended by manufacturer.
 - 6. Splice Joint: Extruded aluminum exposed "H" type, with chalk surfacing applied.
- B. Tackboards, Basis of Design: Claridge 800 Series.
 - 1. Tackboard Material: Cork, color to be selected by Architect.
 - 2. Aluminum Extrusions: ASTM B221, 6063 alloy, T-5 temper.
 - 3. Frame: 5/8 » Face, mitered corners, concealed fasteners.
 - 4. Adhesives: Type recommended by manufacturer.
 - 5. Splice Joint: Extruded aluminum `H' type, with fabric wrapped surface.

2.3 FINISHES

- A. Porcelain Enamel: Glass-fibered enamel, baked to vitreous surfaces; Porcelain Enamel Institute Type A; color: as selected by Architect.
- B. Aluminum Frames and Accessories: Clear anodized finish.
- C. Tackboard Surface: Cork, color as selected by Architect.

PART 3 EXECUTION

3.1 INSPECTION

- A. Verify that surfaces and internal wall blocking are ready to receive work, and opening dimensions are as indicated on shop drawings.
- B. Beginning of installation means acceptance of substrate construction.

3.2 INSTALLATION

- A. Install markerboards, tackboards where located on Drawings in accordance with manufacturer's instructions.
- B. Secure units level and plumb.

3.3 CLEANING

- A. Clean markerboard and tackboard surfaces in accordance with manufacturer's instructions.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Exterior Signages.
 - 1. Accessibility Signage.
 - 2. Dimensional Letters.
- B. Interior Signages.
 - 1. Accessibility Signage.
 - 2. Functional Room Signage.
 - 3. Vinyl Applied Door Graphics.
- C. Life Safety Signages.

1.2 REFERENCES

- A. Unless otherwise noted, standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes as of the date of issue of this Project Manual.
- B. Referenced Standards:
 - 1. ADAAG – Accessibility Guidelines for Buildings and Facilities.
 - 2. ASTM A53/A53M – Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - 3. ASTM A123/A123M – Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - 4. ASTM A283/A283M – Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
 - 5. ASTM A500/A500M – Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
 - 6. ASTM B209 – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - 7. ASTM B221 – Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
 - 8. ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials.
 - 9. ASTM F593 – Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
 - 10. AWS D1.1 – Structural Welding Code – Steel.
 - 11. AWS D1.2 – Structural Welding Code – Aluminum.
 - 12. 2007 CBC.
 - 13. NFPA 101 – Life Safety Code.
 - 14. UL Building Materials Directory.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's descriptive literature and product specification for each product.
- B. Shop Drawings: Submit shop drawing for each sign and plaque to show construction, sections, character spacing and mounting details.
- C. Samples: Submit sign and plaque colors, designs and sizes as specified in this Section and as shown on the drawings for review.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Firm specializing in manufacturing products specified in this Section with a minimum 5 years.

- B. Regulatory Requirements:
 - 1. Accessibility Signage, General: Provide signage in accordance with CCR, Title 24, Part 2, Chapter 11B, CBC.
 - a. The International Symbol of Accessibility shall be the standard used to identify facilities that are accessible to and usable by physically disabled persons.
 - b. Finish, Color, and Contrast: Characters, symbols, and their backgrounds shall have a non-glare finish. Characters and symbols shall contrast with their background and unless otherwise noted, characters and figures shall be white on blue background. Blue shall be Color No. 15090 in accordance with FEDSTD 595B.
 - c. Proportions: Characters on signs shall have a width-to-height ratio between 3:5 and 1:1 and a stroke width-to-height ratio of between 1:5 and 1:10.
 - d. Braille Symbols: Comply with CBC 1117B.5.6. California Contracted Grade 2 Braille, 3/8 inch high. Dots shall be 1/10 inch on centers in each cell with 2/10 inch space between the cells, measured from the second column of dots in the first cell to the first column of dots in the second cell. Dots shall be raised a minimum of 1/40 inch above the background. Braille dots shall be domed or rounded.
 - 2. Accessibility Signage:
 - a. Tactile Exit Signage: Chapter 10 "Means of Egress," Section 1011 "Exit Signs," Article 1011.1 "Where Required," and Article 1011.3 "Tactile Exit Signs."
 - 1) Tactile signs required by Section 1011.3 need not be provided with illumination.
 - b. Other Accessible Signage: Chapter 11B, "Accessibility to Public Buildings, Public Accommodations, Commercial Buildings and Publicly Funded Housing."
 - 1) Sanitary Facilities Signage: Section 1115B, "Bathing and Toilet Facilities (Sanitary Facilities)," Subsection 1115B.6, "Identification Symbols."
 - 2) Telephone Signage: Section 1117B, "Other Building Components," Subsection 1117B.2.9.3, "Signage."
 - 3) Detailed Requirements for Accessible Signage: Section 1117B, "Other Building Components," Subsection 1117B.5, "Signs and Identification."
 - a) Sign Finish: Subsection 1117B.5.2 "Finish and Contrast."
 - b) Sign Proportions: Subsection 1117B.5.3 "Proportions."
 - c) Sign Height: Subsection 1117B.5.4 "Character Height."
 - d) Raised and Pictorial Signs: Subsection 1117B.5.5 "Raised Characters and Pictorial Symbol Signs."
 - e) Braille Signs: Subsection 1117B.5.6 "Braille."
 - f) Sign Mounting: Section 1117B, Subsection 1117B.5.7 "Mounting Location and Height."
 - g) Symbols: Section 1117B, Subsection 1117B.5.8 "Symbols of Accessibility."
 - h) International Symbol of Accessibility: Section 1117B, Subsection 1117B.5.8.1 "International Symbol of Accessibility."
 - i) Entrance Signs: Section 1117B, Subsection 1117B.5.8.1.2 "Entrance Signs."
 - 4) Site Accessibility Signage: Section 1127B, "Exterior Routes of Travel," Subsection 1127B.3, "Signs."
 - 5) Accessible Parking Signage: Section 1129B "Accessible Parking Required."
 - a) Identification Signage: Subsection 1129B.4 "Identification of Parking Spaces for Off-Street Parking Facilities."
 - b) Post or Pylon Mounted Signs: Subsection 1133B.8.6.3 "Free-Standing Signs."
 - c. Field Inspection: Signs and identification shall be field inspected after installation and approved by the enforcing agency, in accordance with Section 1117B,

Subsection 1117B.5.1.4.2 "Inspection."

3. Exit Signage: Provide signage in accordance with CCR, Title 24, Part 2, CBC, Chapter 10 "Means of Egress," Section 1011 "Exit Signs," as applicable to Occupancy Group.
 - a. Illuminated Exit Signs: Subsection 1011.1 "Where Required," Subsection 1011.2 "Illumination," Subsection 1011.4 "Internally Illuminated Exit Signs," and Subsection 1011.5 "Externally Illuminated Exit Signs."
 - b. Floor Exit Signs (SFM Requirement): Subsection 1011.6 "Floor-Level Exit Signs."
 4. Wind Load Requirements: Exterior signages shall be designed to resist wind loads in accordance with CBC.
- C. Pre-Installation Meetings
1. Convene pre-installation meeting one week prior to commencing work of this Section.
 2. Coordinate work in this Section with work in related Sections.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products in manufacturer's original containers, dry and undamaged, with seals and labels intact.
- B. Storage and Protection: Store materials in a dry secure place. Protect from weather, surface contaminants, corrosion, construction traffic, and other potential damage.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers:
 1. Weidner Architectural Signage
 2. ASI-Modulex, Dallas
 3. Mohawk Sign Systems, Inc.
 4. Diverse ID
 5. Or accepted equal.

2.2 MATERIALS

- A. Acrylic Plastic: Non-glare finish acrylic with integral color as manufactured by Romark or accepted equal. Thickness shall be 1/4 inch at door mounted restroom signs and 1/8 inch minimum at all other locations, unless noted otherwise. Colors as selected by Architect from manufacturer's full range of colors.
- B. Aluminum: ASTM B209 for sheet or plate; ASTM B221 for extrusions, and ASTM B26/B26M for castings. Aluminum extrusions shall be 1/8 inch (3mm) thick minimum. Wall and post mounted panels shall be 0.080 inch thick minimum. Aluminum panels shall have an acrylic polyurethane paint finish.
- C. Steel:
 1. Posts: ASTM A53/A53M, Type E or S, Grade B; galvanized 1-1/2 inch nominal pipe size (NPS), Schedule 40. Provide 1/8 inch (3mm) thick steel cap (ASTM A283/A283M) welded to top of post. Galvanize post and cap to minimum G50 in accordance with ASTM A123/A123M.
- D. Vinyl Sheet for Graphics: Precision cut with reflective surface; 5 to 7 year premium type; shall be in accordance with flammability requirements of ASTM E84; minimum 0.003 inch film thickness. Film shall include a precoated pressure sensitive adhesive backing or positionable pressure sensitive backing. Film shall be as manufactured 3M or accepted equal.

- E. Door Graphics: Vinyl; size, color and font as shown on Drawings and as selected by Architect.
- F. Anchors and Fasteners: Stainless steel conforming to ASTM F593.

2.3 EXTERIOR SIGNAGE

- A. Accessible Signage: Provide the following signages in accordance with ADAAG and CBC where indicated on Drawings.
 - 1. Entrance to Parking Lot Sign: 17 inches wide by 22 inches high (minimum) metal panel, reflectorized sign mounted on a single post with text “UNAUTHORIZED VEHICLES PARKED IN DESIGNATED ACCESSIBLE SPACES NOT DISPLAYING DISTINGUISHING PLACARDS OR LICENSE PLATES ISSUED FOR PERSONS WITH DISABILITIES MAY BE TOWED AWAY AT OWNERS EXPENSE. TOWED VEHICLES MAY BE RECLAIMED AT _____ OR BY TELEPHONING _____.”
 - a. Blank Space Text: Coordinate text requirement for blank spaces with County.
 - 2. Accessible Parking Stall Sign: Provide a 12 inch wide by 18 inch high metal panel, reflectorized International Symbol of Accessibility sign, mounted on a single post, at every accessible parking stall indicated on Drawings. The bottom of the sign shall be mounted 80 inches above the finish grade.
 - 3. Van Accessible Parking Stall Sign: Provide a 12 inches wide by 18 inches high metal panel, reflectorized International Symbol of Accessibility sign, mounted on a single post for each van accessible parking stall as indicated on Drawings. Text shall occur below the symbol and read “RESERVED PARKING”. Mounted on the same post, below this sign, a sign of the same width and required height shall display the text “VAN ACCESSIBLE”. The bottom of the sign shall be mounted 80 inches above the finish grade. Refer to drawings for additional sign information.
 - 4. Sign for Parking Violation Fine: An additional sign or additional language below the symbol of accessibility shall state “Minimum Fine \$250.”
 - 5. Accessible Route Signage: Provide where accessible route of travel diverges from the regular circulation path along or leading to an accessible route of travel, entrance or facility. Sign shall display the International Symbol of Accessibility, shall indicate the direction to accessible entrances and facilities, and shall comply with the requirements of CBC Sections 1117B.5.1 and 1117B. 5.8.1.
 - 6. Building Entrance: Provide a 6-inch square International Symbol of Accessibility plaque for public entrances indicated on door schedule.
 - 7. At Solid Wall Surfaces: Minimum 1/8 inch thick, non-glare finish acrylic with integral color and inlaid copy.
 - 8. At Glass Surfaces: Vinyl decal applied to exterior surface of glass.
 - 9. Functional Room Signage: Provide acrylic plastic room signage with inlaid characters raised 1/32-inch, upper case, sans serif type with corresponding California Contracted Grade 2 Braille. Raised characters shall be at least 5/8 inch high, but no higher than 2 inch. Color selections from manufacturer’s full range of colors. Color contrast between characters/symbols and the background shall be 70% minimum per ADAAG 4.30.5.
- B. Exterior Dimensional Letters
 - 1. Material: ASTM B209 water jet cut aluminum plate or ASTM B26/B26M cast aluminum, clear anodized finish.
 - 2. Size and Characters: 12” tall.
 - 3. Font: Helvetica medium, all capital letters, 1 inch thick, 5/8 inch thick strokes.
 - 4. Finish: Provide non-glare type finish.

2.4 INTERIOR SIGNAGE

- A. Accessible Signage: Provide the following signages in accordance with ADAAG and CBC where indicated on the drawings:
 - 1. Material: Acrylic plastic.

2. Color: White symbols and characters on contrasting background. Color contrast between characters/symbols and the background shall be 70% minimum per ADAAG 4.30.5. Colors as selected by Architect from manufacturer's full range of colors.
 3. Mounting Height:
 - a. Doors: Mount signs centered in the width of door 60 inches above the finished floor.
 - b. Walls: Mount signs on wall at 60 inches above the finished floor to the center line of sign on the latch side of the door where a person may approach within 3 inches of signage without encountering protruding objects or standing in the swing of the door.
 4. Restroom Signage:
 - a. Unisex Restroom First Sign (door mounted): Provide for each unisex restroom door (where scheduled) a 12 inch diameter circle with an equilateral triangle superimposed within the circle. Provide a raised international symbol of accessibility, centered on the triangle, at restrooms equipped for the disabled. Triangle shall contrast with the circle a minimum of 70 percent.
 - b. Unisex Restroom Second Sign (wall mounted): Provide for each unisex restroom (where scheduled) 6 inch wide by 10 inch high acrylic plaque, 1/32-inch raised paired male and female pictogram (minimum 6 inch high) imprinted and centered at the top of the sign; 1 inch high by 1/32 inch raised text below the pictogram shall read "RESTROOM"; with corresponding Contracted Grade 2 Braille below the text. Provide 1/32-inch raised pictogram of the international symbol of accessibility beside the male and female pictogram at restrooms equipped for the disabled.
 5. Tactile Exit Signage: Provide acrylic plaque tactile exit signs with at least 1 inch high but no higher than 2 inch high text and corresponding California Contracted Grade 2 Braille 3/8 inch below the text as follows:
 - a. At each grade-level exit door with text "EXIT".
- B. Digital Cut Vinyl Door Graphics: Vinyl Sheet for Graphics: Precision cut with reflecting surface; 5 to 7 year premium type and shall be in accordance with flammability requirements of ASTM E84; minimum 0.003 inch (0.09 mm) film thickness. Film shall include a precoated pressure sensitive adhesive backing or positionable pressure sensitive backing.

2.5 FABRICATION

- A. Work shall be assembled in the shop, as far as practical, ready for installation at the site. Work that cannot be shop assembled be trial fit in the shop to ensure proper field assembly.
- B. Drill or punch holes for bolts and screws; produce clean, true lines and surfaces.
- C. Acrylic signs shall have inlaid acrylic copy/characters and Braille symbols as described in this Section.
- D. Aluminum welding shall be in accordance with AWS D1.2. Steel welding shall be in accordance with AWS D1.1. Welding shall be continuous along the entire area of contact. Grind smooth exposed welds.
- E. Exposed work surfaces shall have a smooth finish and exposed riveting shall be flush. Fastenings shall be concealed where practical.
- F. Galvanized items shall be hot-dip process after fabrication if practical in accordance with ASTM A123/A123M.

2.6 SHOP FINISHING

- A. Surfaces of miscellaneous metal work, except nonferrous metal, corrosion resisting steel,

and zinc-coated work, shall be given one coat of zinc-molybdate primer or an accepted rust-resisting treatment and metallic primer in accordance with manufacturer's standard practice.

- B. Surfaces to be embedded in concrete shall not be painted.
- C. Upon completion of work, damaged surfaces shall be recoated.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install signs and plaques level and plumb.
- B. Mount sign posts directly into concrete foundation. Mount sign to post using tamper resistant mechanical fasteners as recommended by manufacturer and accepted by the Project Manager.
- C. Exterior Accessible Building Entrance Signs and Functional Room Signs: Mount to exterior door and wall surfaces using tamper proof mechanical fasteners suitable for the mounting substrate as recommended by the manufacturer and accepted by the Project Manager.
- D. Accessible Building Entrance Signs: Apply to exterior glass surfaces using vinyl decals.
- E. Exterior Dimensional Letters: Characters shall be installed in a one-line installation and spaced according to templates furnished by the manufacturer. Mount letters 1/4" out from the surface with threaded aluminum inserts, in accordance with manufacturer's installation instructions.
- F. Interior Restroom Signs and Functional Room Signs: Mount to door and wall surfaces with tamper proof mechanical fasteners.
- G. Vinyl Door Graphics: Install per manufacturer's recommendations.

3.2 ADJUST AND CLEAN

- A. Clean and Touch-up: Remove all packing and protection blemishes and thoroughly clean and polish all finish surfaces. Restore any marred or abraded surfaces to their original condition by touching up in accordance with the manufacturer's recommendations. Touch-up shall not be obvious.
- B. Defective Work: Remove and replace all defective work that cannot be properly repaired, cleaned or touched-up, as directed by the Project Manager, with no additional cost to the County.
- C. Protect installed work during the construction period to prevent abuse and damage.

3.3 CLEAN-UP

- A. Upon completion of the work of this Section, remove all surplus materials, rubbish and debris from the premises.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Solid plastic shower stalls with modesty doors, floor and ceiling supported.

1.2 REFERENCES

- A. Unless otherwise noted, standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes as of the date of issue of this Project Manual.
- B. Referenced Standards:
 - 1. ANSI A117.1 – Guidelines for Accessible and Usable Buildings and Facilities.
 - 2. ASTM A666 – Standard Specification Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate and Flat Bar.
 - 3. ASTM B221 – Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
 - 4. ASTM D635 – Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position.
 - 5. ASTM D1929 – Standard Test Method for Determining Ignition Temperature of Plastics.
 - 6. ASTM D2843 – Standard Test Method for Density of Smoke From the Burning or Decomposition of Plastic.

1.3 SUBMITTALS

- A. Samples:
 - 1. Furnish a 1" x 4" sample of compartment material showing color face and finished edges.
 - 2. Furnish one each of stainless steel fasteners, door hardware, mounting hardware and aluminum headrail, as applicable.
- B. Shop Drawings:
 - 1. Provide four copies of all shop drawings.
 - 2. Show fabrication and erection of assemblies, to extent not fully described by manufacturer's data sheets.
 - 3. Show anchorage, accessory items and finishes.
 - 4. Provide location drawings for bolt hole locations in supporting members for attachment of partitions.
- C. Manufacturer's Data:
 - 1. Provide four copies each of:
 - a. Data sheets.
 - b. Installation instructions.
 - c. Maintenance procedures.
- D. Mock-up
 - 1. Provide mock up of door and pilaster assemblies showing all hardware proposed for use on this installation.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Deliver items in manufacturer's original unopened protective packaging.

- B. Store materials in original protective packaging to prevent soiling, physical damage, or wetting.
- C. Handle so as to prevent damage to finished surfaces.

1.5 REGULATORY REQUIREMENTS

- A. Comply with Title 24 CCR, ADAAG, and ANSI A117.1.
- B. Fire Performance Test:
 - 1. Smoke Density: (ASTM D2843): Less than 75.
 - 2. Self-ignition Temperature (ASTM D1929): Minimum 650 degrees F.
 - 3. Rate of Burn (ASTM D635): No more than 2.0 cm/min.

1.6 FIELD MEASUREMENTS

- A. Verify that field measurements are as indicated on shop drawings.

1.7 COORDINATION

- A. Coordinate placement of backing in walls. Backing by others.

1.8 WARRANTY

- A. Manufacturer shall supply a written warranty covering all plastic components for a period of 15 years from the date of Final Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS AND PRODUCTS

- A. Acceptable Manufacturers and Products:
 - 1. Santana/Comtec/Capital (Scranton Products); Product: Floor mounted with full-height pilasters.
 - 2. Partition Systems Incorporated of South Carolina (PSISC).
 - 3. Or accepted equal.

2.2 COMPONENTS:

- A. Components shall be fabricated from high-density polyethylene (HDPE) containing a minimum of 10 percent recycled material manufactured under high pressure forming a single component section which is waterproof, nonabsorbent and that has a self-lubricating surface. Components shall be a minimum of 1" thick and all edges machined to a radius of 0.250" and all exposed surfaces shall be free of saw marks.
- B. Pilasters, doors, and panels shall meet the requirements of ASTM D2843 and D1929. Color: Bronze; Hammered.
 - 1. Panel and modesty door sizes shall be as shown on the drawings.
 - 2. Pilasters shall be custom length full height and fastened to a 3 inch high stainless steel pilaster shoe at top and bottom (Type 304, 20 gauge) with a stainless steel, tamper resistant torx head sex bolt.
- C. Brackets: Continuous aluminum bracket Type 6436-T5 (ASTM B221) weighing not less than 1.5 pounds per linear foot; bright dip anodized finish.

- D. Hinges: Self-closing continuous aluminum bracket Type 6463-T5 (ASTM B221) with bright dip anodized finish. Door closers shall be factory set to accommodate all conditions and allow for a positive opening and closing action free of impediment.
- E. Strike: 6" long Aluminum Type 6463-T5 (ASTM B221); bright dip anodized finish; wrap around flanges – minimum 5/32 inch wall thickness; bumper shall be made of extruded black vinyl.
- F. Bolts, nuts, fasteners: Type 304 stainless steel, tamper-proof type.
- G. Accessible stall doors shall be self-closing and shall have ADA and CBC compliant door pulls.
- H. Latch: No latches shall be included.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that site conditions are ready to receive work and opening dimensions are as instructed by the manufacturer.
- B. Verify correct spacing of plumbing fixtures.
- C. Verify correct location of built-in framing, anchorage and bracing, where required.
- D. Beginning of installation means acceptance of existing substrate.

3.2 INSTALLATION

- A. Install partitions secure, plumb, and level in accordance with manufacturers' instructions.
- B. Maintain 3/8" to 1/2" space between wall and panels and between wall and end pilasters.
- C. Attach panel brackets securely to walls using anchor devices.
- D. Attach panels and pilasters to bracket with tamper-proof bolts and nuts.
- E. Secure all elements rigidly in place. Anchor to structure with anchors appropriate for use with type of adjacent construction. Fasteners shall securely fasten items to wall construction involved. Fasteners shall provide stiffness and rigidity to keep items square, in accurate position without twisting, buckling or warping. Fasteners to framing substrate shall be the following minimums; greater as required by the toilet partition manufacturer or as conditions warrant:
 - 1. Masonry: #14 corrosion resistant screws 2-1/2" long with expansion shields.
- F. Provide adjustment for floor variations with screw jack through steel saddles integral with pilaster. Conceal floor fastenings with pilaster shoes.
- G. Equip each door with one continuous hinge.
- H. Install door strike with door bumper on each pilaster.

- I. Adjust hinges to locate doors in closed position.

3.3 ADJUSTING

- A. Adjust and align hardware to uniform clearance at vertical edge of doors, not exceeding 3/16".

3.4 CLEANING

- A. Remove protective masking. Clean surfaces.
- B. Field touch-up of scratches or damaged finish will not be permitted.
- C. Replace damaged or scratched materials with new materials.

END OF SECTION

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes: Requirements including but not limited to:
 - 1. Corner guards.
 - 2. Accessories necessary for a complete installation.

1.2 SUBMITTALS

- A. All submittals shall be made under the provisions of Section 01 33 00 Submittal Procedures. Contractor initial submittal shall include 'Submittal Items' requested below. 'Closeout Submittal Items' shall be provided as required by Section 01 77 00 Closeout Procedures.
- B. Submittal Item No. 10 26 13 A – Product Data:
 - 1. Product data and detailed specifications for each system component and installation accessory required, including installation methods for each type of corner guard.
- C. Submittal Item No. 10 26 13 B – Installation Instructions:
 - 1. Shop drawings showing locations, extent and installation details of corner guards. Show methods of attachment to adjoining construction.
- D. Submittal No. 10 26 13 C – Product Samples:
 - 1. Samples for verification purposes: Submit the following samples, as proposed for this work, for verification of guard:
 - a. 12 inches (304.8mm) long sample of each model specified.
- E. Submittal No. 10 26 13 D – Technical Data:
 - 1. Information for each product, including construction details, material descriptions, impact strength, dimensions of individual components and profiles, and finishes.
 - 2. Fire Ratings: Where applicable, indicate fire ratings of units recessed in fire rated walls and listings for door protection items attached to fire rated doors.
- F. Submittal No. 10 26 13 E – Shop Drawings:
 - 1. Submit for each wall and door protection showing locations and extent of work including plans, elevations, sections, and attachment details. Show handrail design and support spacing required to withstand structural loads.

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Surface Burning Characteristics: Comply with ASTM E 84 or UL 723; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - a. Flame Spread Index: 25 or less.
 - b. Smoke Developed Index: 450 or less.
 - 2. Accessibility Requirements: Comply with applicable requirements.
 - a. U.S. Architectural and Transportation Barriers Compliance Board Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG) 2010.
 - b. ICC/ANSI A117.1 Accessible and Useable Building and Facilities.
 - c. CBC, Section 11B Accessibility.
- B. Source Limitations: Obtain wall and door protection products from single source from single

manufacturer.

- C. Installer qualifications: Engage an installer who has no less than 3 years' experience in installation of systems similar in complexity to those required for this project.
- D. Manufacturer's qualifications: Not less than 5 years' experience in the production of specified products and a record of successful in-service performance.

1.4 WARRANTY

- A. Warranty: Written warranty in which the manufacturer agrees to repair or replace components of wall and door protection units that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including detachment of components from each other or from the substrates, delamination, and permanent deformation beyond normal use.
 - b. Deterioration of metals, metal finishes, plastics, and other materials beyond normal use.
 - 2. Warranty Period: Five years from date of Substantial Completion.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store wall and door protection in original undamaged packages and containers inside well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.
 - 1. Maintain room temperature within storage area at not less than 70 degrees F (21 degrees C) during the period plastic materials are stored.
 - 2. Keep plastic materials out of direct sunlight.
 - 3. Store plastic wall and door protection components for a minimum of 72 hours, or until plastic material attains a minimum room temperature of 70 degrees F (21 degrees C).
 - a. Store corner guard covers in a vertical position.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Aluminum: Continuous 6063-T6 aluminum retainer behind entire height of corner guard, minimum 0.060 inch thick.
- B. Plastic Materials: Chemical and stain resistant, high impact resistant plastic with integral color throughout; extruded and sheet material as required, thickness as indicated.
- C. Fasteners: Aluminum, nonmagnetic stainless steel, or other noncorrosive metal screws, bolts, and other fasteners compatible with items being fastened. Use security type fasteners where exposed to view.
- D. Adhesive: Recommended by protection product manufacturer.

2.2 WALL PROTECTION

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Basis of Design: Construction Specialties, Inc., Acrovyn; McQuarrie Assoc., Inc., Ste. 401, 605 Market St., San Francisco, CA 94105, Ph: (415) 495-4475, Fax: (415) 543-

6568, Email: sharol@mcqsf.com, Web: www.mcquarrieassociates.com

2. InPro Corporation (IPC).
3. JL Industries, Inc.
4. Korogard Wall Protection Systems.

- B. Surface Mounted, Metal Corner Guards: Fabricated as one piece from formed or extruded metal with formed edges; with 90 degree or 135 degree turn to match wall condition.
1. Material: Stainless steel sheet, Type 304.
Optional: Aluminum alloy 5005 H34 with clear anodized finish.
 - a. Thickness: Minimum 0.0625 inch (1.6 mm).
 - b. Finish: Directional satin, No. 4.
 2. Wing Size: Nominal 3-1/2 inches by 3-1/2 inches (90 mm by 90 mm).
 3. Corner Radius: 1/8 inch (3 mm) to 3/16 inch (4.8mm).
 4. Mounting: Construction adhesive standard; optional flat head, stainless steel countersunk screws through factory drilled mounting holes.

2.3 FABRICATION

- A. Fabricate wall and door protection according to requirements indicated for design, performance, dimensions, and member sizes, including thicknesses of components.
- B. Factory Assembly: Assemble components in factory to greatest extent possible to minimize field assembly. Disassemble only as necessary for shipping and handling.
- C. Fabricate components with uniformly tight seams and joints and with exposed edges rolled. Provide surfaces free of wrinkles, chips, dents, uneven coloration, and other imperfections. Fabricate members and fittings to produce flush, smooth, and rigid hairline joints.

2.4 FINISHES

- A. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- C. General: Comply with NAAMM "Metal Finishes Manual" for recommendations relative to applications and designations of finishes.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine substrates and wall areas for compliance with requirements for installation tolerances, fire rating, and other conditions affecting performance of the work.
- B. Examine walls to which wall and door protection will be attached for blocking, grounds, and other solid backing that have been installed in the locations required for secure attachment of support fasteners.
- C. Proceed with installation only after correcting unsatisfactory conditions.

3.2 PREPARATION

- A. Surface preparation: Prior to installation, clean substrate to remove dirt, debris and loose particles. Perform additional preparation procedures as required by manufacturer's instructions.
- B. Protection: Take all necessary steps to prevent damage to material during installation as required in manufacturer's installation instructions.
- C. Complete finishing operations, including painting, before installing wall and door protection.
- D. Prior to installation, clean substrate to remove dust, debris, and loose particles.

3.3 INSTALLATION

- A. Installation Quality: Install wall protection according to manufacturer's written instructions, level, plumb, and true to line without distortions. Do not use materials with chips, cracks, voids, stains, or other defects that might be visible in the finished Work.
- B. Mounting Heights: Install wall and door protection in locations and at mounting heights indicated on Drawings.
- C. Accessories: Provide splices, mounting hardware, anchors, trim, joint moldings, and other accessories required for a complete installation.
 - 1. Provide anchoring devices and suitable locations to withstand imposed loads.
 - 2. Where splices occur in horizontal runs of more than 20 feet (6.1 m), splice aluminum retainers and plastic covers at different locations along the run, but no closer than 12 inches (305 mm) apart.
 - 3. Adjust end and top caps as required to ensure tight seams.

3.4 CLEANING

- A. Immediately after completion of installation, clean plastic covers and accessories using a standard ammonia based household cleaning agent insuring a streak-free finished product.
- B. Remove surplus materials, rubbish and debris resulting from installation as work progresses and upon completion of work.

3.5 PROTECTION

- A. Protect installed materials to prevent damage by other trades. Use materials that may be easily removed without leaving residue or permanent stains.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Toilet accessories.
- B. Attachment hardware.

1.2 REFERENCES

- A. Unless otherwise noted, standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes as of the date of issue of this Project Manual.
- B. Referenced Standards:
 - 1. ASTM A167 – Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip.
 - 2. ASTM A269 – Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.

1.3 SUBMITTALS

- A. Product Data: Submit data on accessories describing size, finish, details of function, attachment methods.
- B. Manufacturer's Installation Instructions: Submit installation instructions, special procedures, and conditions requiring special attention.

1.4 KEYING

- A. Master key all accessories.

1.5 REGULATORY REQUIREMENTS

- A. Conform to applicable code for installing work in conformance with Title 24 and Accessibility Requirements.
 - 1. Toilet accessories required to be accessible shall be mounted at heights according to CBC Section 1115B.8.
 - 2. Toilet paper and feminine napkin disposals located on the grab side of an accessible toilet room or stall shall not project more than the grab bar. The grab bar cannot project more than 3" into the 48" minimum clear space in front of the water closet per CBC 1115B.4.1.3. The accessory shall not be located closer than 1-1/2" clear of the tangent point of the grab bar.

1.6 SEQUENCING AND SCHEDULING

- A. Coordinate the work of this Section with the placement of internal wall reinforcement and reinforcement of toilet partitions to receive anchor attachments.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Bobrick.

- B. American Specialties, Inc.
- C. Bradley.
- D. Or accepted equal.

2.2 MATERIALS

- A. Stainless Steel Sheet: ASTM A167, Type 304.
- B. Tubing: ASTM A269, stainless steel.
- C. Fasteners, Screws, and Bolts: Hot dip galvanized, tamperproof.
- D. Expansion Shields: Fiber, lead, or rubber as recommended by accessory manufacturer for component and substrate.

2.3 FABRICATION

- A. Weld and grind smooth joints of fabricated components.
- B. Form exposed surfaces from single sheet of stock, free of joints.
- C. Form surfaces flat without distortion. Maintain flat surfaces without scratches or dents.
- D. Back paint components where contact is made with building finishes to prevent electrolysis.
- E. Shop assemble components and package complete with anchors and fittings.
- F. Provide steel anchor plates, adapters, and anchor components for installation.
- G. Hot dip galvanize exposed and painted ferrous metal and fastening devices.

2.4 FACTORY FINISHING

- A. Stainless Steel: No. 4 satin luster finish.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that site conditions are ready to receive work and dimensions are as instructed by the manufacturer.
- B. Beginning of installation means acceptance of existing conditions.

3.2 PREPARATION

- A. Deliver inserts and rough-in frames to site at appropriate time for building-in.
- B. Provide templates and rough-in measurements as required.
- C. Verify exact location of accessories for installation.

3.3 INSTALLATION

- A. Install fixtures, accessories and items in accordance with manufacturers' instructions.
- B. Install all items plumb and level.
- C. Secure all items rigidly in place. Anchor to structure with anchors appropriate for use with type of adjacent construction. Fasteners shall securely fasten items to wall construction involved. Fasteners shall provide stiffness and rigidity to keep items square, in accurate position without twisting, buckling or warping. Fasteners to framing substrate shall be the following minimums; greater as required by the toilet accessory manufacturer or as conditions warrant:
 - 1. Metal Framing: #10 corrosion resistant self-tapping sheet metal screws by length as required to penetrate framing member 1/4" minimum.
 - 2. Concrete/Masonry: #10 corrosion resistant screws 2-1/2" long with expansion shields.

3.4 SCHEDULE

- A. . Refer to drawings for items required at each space.
 - B. Basis of Design:
 - 1. Soap Dispenser, Surface Mounted B-2111
 - 2. Toilet Tissue Dispenser, Non-Detention Surface Mounted B-2740
 - 3. Toilet Seat Cover Dispenser, Surface Mounted B-221
 - 4. Sanitary Napkin Disposal, Surface Mounted B-254
 - 5. Paper Towel Dispenser and Waste Receptacle, Surface Mounted B-3699
 - 6. Grab Bar, Non-Detention B-6806
 - 7. Mirror, Non-Detention B-290
- 2448

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Fire Extinguishers.
- B. Cabinets.
- C. Accessories.

1.2 REFERENCES

- A. Unless otherwise noted, standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes as of the date of issue of this Project Manual.
- B. Referenced Standards:
 - 1. CCR, Title 19, Division 1, Chapter 3, Article 4 "Classification and Ratings of Portable Fire Extinguishers".
 - 2. California Fire Code (CFC) – Section 906, Portable Fire Extinguishers.
 - 3. UL 299– Standard for Dry Chemical Fire Extinguishers.

1.3 SUBMITTALS

- A. Shop Drawings: Indicate cabinet physical dimensions, rough-in measurements for recessed cabinets and location.
- B. Product Data: Provide extinguisher operational features, color and finish, and anchorage details.
- C. Manufacturer's Installation Instructions: Indicate special criteria and wall opening coordination requirements.
- D. Manufacturer's Certificate: Certify that Products meet or exceed specified requirements.

1.4 OPERATION AND MAINTENANCE DATA

- A. Maintenance Data: Include test, refill or recharge schedules and re-certification requirements.

1.5 REGULATORY REQUIREMENTS

- A. Conform to CFC Section 906 for requirements for extinguishers.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers and Products:
 - 1. J.L. Industries, Inc.
 - 2. Larsen's Manufacturing Co.
 - 3. Potter-Roemer
 - 4. Or accepted equal.

2.2 EXTINGUISHERS

- A. Dry Chemical Type, UL 299, five pound capacity, enameled steel tank, with pressure gage; minimum 2A-10B:C Rating.
- B. Wet chemical type, 2.5 gallon, Class K fires. J.L. Industries Saturn 25 or accepted equal.

2.3 CABINETS

- A. Semi-Recessed, Non-Security: Cosmopolitan Series, Model No. 1037W18 by J.L. Industries, Inc. Provide the named product or accepted equal with the following properties:
 - 1. Door and Trim: Formed sheet stainless steel.
 - 2. Trim Style: Rolled trim.
 - 3. Tub: Cold rolled steel with #4 satin stainless steel finish.
 - 4. Door Glazing: Laminated safety glass.
 - 5. Cabinet Hardware: Flush cabinet doors with 5/8" stop, attached by a continuous hinge; equipped with zinc-plated handle and roller catch.
 - 6. Cabinet Mounting Hardware: Appropriate to cabinet.
- B. Surface Mounted, Non-Security Cabinet, model 1039W18 by JL Industries. Provide the named product or accepted equal with the following properties.
 - 1. Door and Trim: Formed sheet stainless steel.
 - 2. Trim Style: Rolled trim.
 - 3. Tub: Cold rolled steel with #4 satin stainless steel finish.
 - 4. Door Glazing: Laminated safety glass.
 - 5. Cabinet Hardware: Flush cabinet doors with 5/8" stop, attached by a continuous hinge; equipped with zinc-plated handle and roller catch.
 - 6. Cabinet Mounting Hardware: Appropriate to cabinet.
- C. Semi-recessed: Security Cabinet, Model No. SSFC-32 by J.L. Industries, Inc. Provide the named product or accepted equal with the following properties:
 - 1. Door: 14-gauge stainless steel with #4 satin edge.
 - 2. Trim Style: 2-1/2-inch square trim with white powder coat primer finish.
 - 3. Tub: 14-gauge stainless steel with #4 satin finish.
 - 4. Door Glazing: None.
 - 5. Cabinet Hardware: Flush cabinet doors with 5/8" stop, attached by a continuous hinge; equipped with flush cup pull.
 - 6. Cabinet Lock: Model MDP-SL-1E74, factory installed mortise deadbolt with blank construction core to be keyed on site.
 - 7. Cabinet Mounting Hardware: Appropriate to cabinet. Provide tamper-proof security fasteners at exposed fasteners.
- D. Surface-mounted: Security Cabinet, Model No. SSFC-33 by J.L. Industries, Inc. Provide the named product or accepted equal with the following properties:
 - 1. Door: 14-gauge stainless steel with #4 satin finish.
 - 2. Trim Style: Trimless, with square edge.
 - 3. Tub: 14-gauge stainless steel with #4 satin finish.
 - 4. Door Glazing: None.
 - 5. Cabinet Hardware: Flush cabinet doors with 5/8" stop, attached by a continuous hinge; equipped with flush cup pull.
 - 6. Cabinet Lock: Model MDP-SL-1E74, factory installed mortise deadbolt with blank construction core to be keyed on site.
 - 7. Cabinet Mounting Hardware: Appropriate to cabinet. Provide tamper-proof security fasteners at exposed fasteners.

- E. Fabrication:
 - 1. Form cabinet enclosure with right angle inside corners and seams. Form perimeter trim and door stiles.
 - 2. Pre-drill for anchors.
 - 3. Hinge doors for 180 degree opening with continuous piano hinge.
 - 4. Weld, fill and grind components smooth.
 - 5. Prepare security cabinets for mortise deadbolt.

2.4 FIRE EXTINGUISHER WALL BRACKET

- A. Wall Bracket: Model No. MB818C by J.L. Industries, Inc. Provide the named product or accepted equal with the following properties:
 - 1. Material: Steel.
 - 2. Finish: Powder coat paint; color: red.
 - 3. Fasteners: Tamper-proof security fasteners appropriate to wall bracket and wall substrate.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify rough openings for cabinet are correctly sized and located.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Mount cabinets and wall brackets such that the fire extinguisher handle is at 48" maximum above the finished floor.
- C. Install cabinets and wall brackets plumb and level.
- D. Secure cabinets and wall brackets rigidly in place. Anchor to structure with anchors appropriate for use with type of adjacent construction. Anchorage shall securely fasten items to wall construction involved. Fasteners shall provide stiffness and rigidity to keep items square, in accurate position without twisting, buckling or warping. Fasteners to framing substrate shall be the following minimums; greater as required by the cabinet/bracket manufacturer or as conditions warrant:
 - 1. Metal Framing: Three-#10 self-tapping sheet metal screws each side of cabinet by length as required to penetrate framing member 1/4" minimum.
 - 2. Masonry: Masonry Anchors, 1/4 inch by 2 inch Torx concrete screws, hex washer head, Perma-Seal coated carbon steel.
- E. Place extinguishers in cabinets and on wall brackets.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Adjustable wall mount for flat panel TV monitor. Accessories including anchors and fasteners for installation.

1.2 SUBMITTALS

- A. Shop Drawings
 1. Indicate fabrication, materials, installation details, finishes, and any other required anchoring, fastenings, and hardware.
 2. Submit drawing layout for product configuration, support attachment and anchorage details.

1.3 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Store in manufacturer's original unopened containers and packaging. Protect and handle products to prevent damage to products or finishes.

PART 2 PRODUCTS

2.1 WALL MOUNT FOR FLAT PANEL TV MONITOR

- A. Adjustable Wall Mount: Universal mount suitable for supporting flat panel TV monitors.
 1. Basis-of-Design Product: Model PDS-LWA by Video Mount Products (VMP)
 - a. Lucasey Manufacturing Corporation
 - b. Peerless Industries, Inc.
 - c. Or accepted equal.
- B. Adjustable Wall Mount Features:
 1. Maximum Load Capacity: 180 lbs.
 2. Color: Silver.
 3. Mounting Range: 42 inch to 63 inch flat panel TV monitors.
 4. Rotation: Up to 45 degrees.
 5. Tilt: -5 degrees to +15 degrees.
 6. Size: 38 inches by 13 inches.
 7. Depth of Mount: 4.3 inches from wall surface collapsed, 24 inches from wall surface fully extended.
- C. Provide fastener kit for metal studs as standard with manufacturer.

PART 3 EXECUTION

3.1 PREPARATION

- A. Blocking and Backing: Verify mounting location; install blocking and backing as required by wall construction, and as recommended by manufacturer, for anchoring TV mount assembly.

3.2 INSTALLATION

- A. Products shall be installed according to manufacturer's printed instructions and as detailed on Drawings.
 - 1. Coordinate exact location of TV monitors with County.

3.3 ADJUST AND CLEAN

- A. Clean and Touch-up: Remove all packing and protection blemishes and thoroughly clean finish surfaces. Restore any marred or abraded surfaces to their original condition by touching up in accordance with the manufacturer's recommendations. Touch-up shall not be obvious.
- B. Defective work: Remove and replace all defective work which cannot be properly repaired, cleaned or touched up, as directed by Project Manager, at no cost to County.
- C. Protect installed work during the construction period to prevent damage.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Detention Equipment Contractor.
- B. Suppliers.
- C. Installers.

1.2 REFERENCES

- A. ASTM A36 – Structural Steel.
- B. ASTM A366 – Steel, cold rolled.
- C. ASTM A526 – Galvanized Steel.
- D. ASTM A569 – Commercial Grade, hot rolled and pickled steel.
- E. FS FF-S325 – Expansion Anchors, and Anchor Bolts.
- F. FS QQ-A325 – Finish for Wedge Type Expansion Anchor.

1.3 SUBMITTALS

- A. Submit complete shop drawings for fabrication, erection and installation of all items of detention equipment. Include plans, elevations and large scale details. Show anchorage and accessory items, and include electrical junction boxes, conduit and wiring locations and connections, to insure a complete and proper installation. All shop drawings shall be referenced to Architect's Door Schedule, Glazing Schedule, Detail Numbers and Hardware Group as applicable.
- B. The Detention Equipment Contractor shall coordinate and submit "Composite"-type shop drawings. Show complete details of construction including glazing, glazing stops, relites, doors, door frames, all hardware and electronic products, reinforcements, joints, connections, and all other related types of construction; also include methods of installation including anchorage and include diagrams showing the sequence of installation. All shop drawings shall be referenced to Architect's Door Schedule, Glazing Schedule, Detail Number and Hardware Group Number as applicable.
- C. Project Manager will not process submittals that are nonconforming to this Subsection. All delays and time overruns caused by incomplete submittals may be assessed to Contractor.
- D. Composite-type shop drawings shall include materials and installation of Sections 08 34 63 "Detention Doors and Frames", 08 71 63 "Detention Door Hardware", 11 19 23 "Detention Fasteners" and 11 98 36 "Detention Furnishings", and shall be coordinated with all other related sections including those listed above in Subsection 1.2, Related Sections.
- E. Submit manufacturer's product data and installation instructions for each standard equipment and hardware item.
- F. Detention Equipment Contractors shall provide the following information.
 - 1. Brief description of the firm including length of time in business.

2. List of all projects the firm has worked on in the last five years. List Title, Location, County Contact, General Contractor, Architect, services provided and dollar value of your service. Identify those projects of equal size and service to this project.
3. List of five references with phone numbers who can attest to your qualifications, expertise and quality of work.
4. Résumés of key personnel within your company and of those who will be involved with this project as a manager, fabricator or installer, along with each person's particular expertise and years of service.
5. Provide a brief financial statement describing the stability of the company.
6. Provide a letter from Surety Company outlining bonding capabilities, overall limit and current bonds outstanding. List occurrences in the last five years where a bonding company was drawn upon to complete any work on your projects.
7. If you propose subcontracting any of your services, provide information and bonding capabilities on this subcontractor.
8. Provide a list of services you propose to provide as part of this project. Include also a list of those services you will specifically exclude from this project.

Note: Approval of a firm as Detention Equipment Contractor does not relieve them from furnishing all materials and services required by the Contract Documents."

1.4 OPERATIONS AND MAINTENANCE DATA

- A. Detention equipment manufacturer shall furnish operating and specifications manuals for all detention equipment and provide instruction for the care of finishes and materials.

1.5 QUALITY ASSURANCE

- A. The Detention Equipment Contractor shall be responsible for:
 1. Providing and installing all items and equipment specified in Sections 08 34 63 "Detention Doors and Frames", 08 71 63 "Detention Door Hardware", 11 19 23 "Detention Fasteners" and 11 98 36 "Detention Furnishings".
 2. Coordination of all interfaces of his work with fabrication and installation of items specified in Sections listed in Subsection 1.2 Related Sections.
 3. Compliance with all requirements as listed in each section of specifications for which he is responsible.
- B. The Detention Equipment Contractor shall exhibit the following qualifications: Subcontract the provision of detention equipment to a single firm. The firm shall meet the following minimum requirements:
 1. Detention Equipment Provider shall be regularly and presently engaged in the design, fabrication, and installation of detention equipment as one of its principal products.
 2. Detention Equipment Provider shall have technically qualified, experienced and trained personnel, with a minimum of five years experience, to install specified items.
 3. Detention Equipment Provider shall have executed as least five separate detention and/or correction projects equal or greater in size than this Project which embody the same type of detention equipment as proposed for this Project. These Projects shall have been in actual and satisfactory use for not less than one year.
- C. Qualification of Detention Equipment Subcontractors: Use only subcontractors acceptable to all detention equipment manufacturers and to the Detention Equipment Contractor. Use adequate numbers of skilled workmen thoroughly trained and experienced in the necessary crafts, who are completely familiar with the specified requirements and methods needed for proper performance of the work.
- D. Qualifications of Manufacturers: Products used in the work of these Sections shall be produced by manufacturers regularly engaged in manufacture of detention equipment and

with a history of successful production acceptable to the Project Manager.

- E. Furnish all items to be embedded in other work. Include instructions for placement. Review installation of embedded items and report status of installation to the Project Manager.
- F. Detention equipment Provider shall perform final field installation of detention doors, hardware, and other detention equipment.

PART 2 PRODUCTS

2.1 MATERIALS

- A. General
 - 1. The manufacturers, suppliers and warrantors shall make special efforts to comply with Contractor's scheduling requirements with regard to early delivery of hollow metal frames and other items needed to proceed with adjacent or related work.
 - 2. The Detention Equipment Contractor is responsible for providing detention equipment detention metal frame assemblies, complete with all products required, for putting in operable condition all items of work and for furnishing all items required for complete installation of products including anchors, and other necessary fasteners/accessories for anchorage as required by conditions of installation.
- B. Materials, Components and Fabrication: Comply with requirements in each Section of detention equipment and/or furnishings; provide direct to Contractor each type of detention equipment only from a single detention equipment contractor.

PART 3 EXECUTION

3.1 INSTALLATION

- A. General:
 - 1. Do not install products that are damaged or defective.
 - 2. Securely anchor products in locations indicated on drawings, or as recommended by manufacturer and accepted by Architect.
 - a. Install in alignment, free from warp, twist or distortion, plumb, level and true.
 - b. Comply with reviewed shop drawings, manufacturer's instructions and recommendations for both handling and installation of the products for particular conditions of installation in each case, except:
 - 1) Where more stringent requirements are indicated or specified.
 - 2) Where project conditions require extra precautions or provisions for satisfactory performance of work.
 - 3. Where printed instructions are not available or do not apply to project conditions, consult manufacturer's technical representative for specific recommendations before proceeding.
- B. Cutting, Fitting and Placement
 - 1. Perform cutting, drilling and fitting required for installation of detention equipment.
 - 2. Set work accurately in location, alignment and elevation, plumb, level, true and free of rack, measured from established lines and levels with lines visually parallel.
 - 3. Cut necessary holes for installation of mechanical and electrical work in detention equipment; comply with templates or detail drawings furnished by other trades prior to fabrication and installation of detention work.
- C. Provide all anchors and other attachment devices necessary to install County-furnished

Contractor-installed detention equipment.

3.2 ADJUSTING, REPAIRING AND CLEANING

- A. After connections to electrical power are made, test products to verify operational characteristics.
- B. Adjust and lubricate moving parts to operate smoothly, quietly and without binding.
- C. Remove from product surfaces the manufacturer's temporary labels, protective coatings and marks of identification if provided; thoroughly wash surfaces and remove foreign material.
- D. After erection, prior to touch-up painting, remove objectionable foreign material from metal surfaces including connections. Where surfaces are to be exposed to view, grind welds smooth; finish holes, defects, and other imperfections so surfaces will be smooth when painted. Use metal body filler to fill joints at metal-to-metal joints or other gaps as directed by Project Manager including all joints or gaps in field assembled detention hollow metal items or detention equipment. Any gaps greater than 1/4" between detention hollow metal or detention equipment and CMU walls to be closed with 1/8" steel angle or 1/8" steel plate and sealed with security sealant as appropriate for a neat installation. All gaps of less than 1/4" are to be sealed. This shall include all areas in secure perimeter as the Project Manager shall deem necessary.
- E. Touch-up welds, bolted connections and all abraded/damaged areas in shop-applied finish with same type paint as metal primer used in fabrication shop.
- F. Work shall be free from scratches, dents, permanent discoloration and other defects. Remove and replace damaged parts, and surfaces with imperfections, or items damaged during installation or thereafter before time of final project acceptance. Leave entire work in neat, orderly, clean condition.

3.3 PROTECTION

- A. Protect products installed by detention equipment installer from damage.

3.4 EXTRA STOCK/SPARE PARTS

- A. Provide six sets of special tools to manually operate motor controlled doors. Delivery shall be by registered mail direct to County.
- B. Provide at least three screwdrivers (or special wrenches, if applicable) for each size and type of countersunk flat security head metal screw.
- C. Deliver extra stock/spare parts to authorized County's representative at project site packed in a carton to provide protection during transit and project site storage; store where directed and obtain written receipt when delivered.

3.5 INSTRUCTION AND TRAINING PERIOD

- A. Provide operating/maintenance manuals and instructions as specified in the Contract.
- B. Detention equipment supplier shall provide a representative acceptable to Project Manager and specially trained in operation of detention equipment, with thorough knowledge of its mechanisms, for an on-site instruction and training period involving County's designated personnel (which will not exceed five 8-hour days in length but shall be a minimum of three

8-hour days in length). Representative must be capable of training personnel in operation of detention equipment and instructing maintenance personnel in its operation, repair and upkeep. Detention equipment supplier shall obtain signatures from these designated personnel verifying their participation in this training, and shall forward this verification to Project Manager and County for review.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Security Screws.

1.2 COORDINATION

- A. Coordinate Work and scheduling of the Work of this Section with other trades for anchorage and location.

1.3 INSPECTION

- A. Examine all subsurfaces to receive Work and report, in writing, to Contractor, with a copy to the Company, any conditions detrimental to work. Failure to observe this injunction constitutes a waiver to any subsequent claims to the corrections the Company may require. Commencement of Work will be construed as acceptance of all subsurfaces.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Deliver all manufactured materials in original containers bearing manufacturer's name and brand. Use only one brand for material throughout job. Store materials within building in locations directed by Contractor.

PART 2 PRODUCTS

2.1 SECURITY SCREWS

- A. All exposed fasteners in the project, including fasteners used in fabrication of project components, shall be Security Screws as specified herein, whether called for on the drawings or not, unless the components or location is specifically excluded by inclusion on the list below.
- B. Excluded Items and Locations:
 - 1. Mechanical, electrical, generator or electronic equipment rooms, including roof-mounted equipment.
 - 2. Control rooms and attendant equipment in those rooms, except control panel.
 - 3. Above suspended ceilings, behind access panels and within pipe or duct chases.
 - 4. Wall board screws.
 - 5. All areas not within the secure perimeter of the facility.
- C. All security screws shall be operable by tools produced for use on the specified security screws by manufacturer or other fabricators licensed by them.
- D. Security screw head style and plating shall be selected as appropriate for installation requirements, strength and finish of adjacent materials except that all screws in painted materials shall be stainless steel. Size and shape variation shall be such that no more than six different tools/wrenches are required for all security screws on projects.
- E. Types Allowed:
 - 1. Pinned "Allen" head.
 - 2. Pinned "Torx" head.

- F. Provide six complete sets of tools required for all security screws on the project.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Installation shall be made in accordance with the manufacturer's instructions.
- B. Check and adjust all operating mechanisms to insure proper function in accordance with the manufacturer's recommendation.

END OF SECTION

PART 1 GENERAL

1.1 DESCRIPTION:

- A. The conditions of the Contract and Division 1 apply to this section as fully as if repeated herein.
- B. Work to be provided and installed includes, but is not limited to:
- C. Furnish all labor, materials and services necessary for the assembly and setting in place of the equipment in strict compliance and in accordance with the contract documents.
 - 1. Cut holes; provide sleeves for pipes on equipment, for drains, electrical, plumbing, etc., as required for proper installation.
 - 2. Repair any damage resulting from installation.
 - 3. Remove all debris resulting from this installation, clean and all equipment for operation, as well as an acceptance test by the Owner.

1.2 WORK PERFORMED BY SECTIONS OTHER THAN FOODSERVICE EQUIPMENT

- A. Mechanical and Plumbing and Utilities: Mechanical and Plumbing rough-in; ducting, piping and final connection between rough-in and equipment; installation of mechanical and plumbing devices and fittings in utility lines; interconnecting field ducting and piping between foodservice equipment and components; exhaust ducts, exhaust fans, indirect waste lines, floor cleanouts and floor sinks.
- B. Electrical rough-in; conduit, conductors and final connection between rough-in and equipment; installation of electrical fittings and devices in utility lines; interconnecting field wiring between foodservice equipment and components; circuit breakers panels other than those integral with foodservice equipment; final disconnect means.

1.3 CONTRACT DOCUMENTS

- A. Equipment drawings are definitive only and should not be used as construction documents or shop details.
- B. Drawings and equipment specifications are intended to complement each other. Therefore, neither should be considered complete without the other.
- C. Drawings are for reference, assistance and guidance only. They indicate the preferred final location of equipment. The exact final location will be dictated by the building conditions.
- D. Plans shall govern for quantity, irrespective of equipment schedule quantities shown, and specifications for quality.

1.4 LAWS AND ORDINANCES

- A. Certify that all work and materials comply with Federal, State and Local laws, ordinances and regulations and is confirmed by the local inspector having jurisdiction.
- B. Work and materials must be in full accord and when appropriate, shall be listed with the following agencies:
 - 1. Local Health Department
 - 2. National Sanitation Foundation (N.S.F.)

3. Underwriters Laboratories (U.L.) or ETL equivalent
 4. A.G.A.
 5. N.F.P.A. – latest edition, for exhaust system
- C. Check and confirm that drawings and specifications meet all Federal, State and Local Government bodies. The drawings and specifications shall govern wherever they require larger sizes or higher standards than required by local agencies and regulations. The regulation shall govern when drawings and specifications indicate less than the required regulation. Owner shall not be held responsible or be charged extra charges related to code compliance.

1.5 QUALITY ASSURANCE

- A. Qualifications
1. Foodservice Equipment Contractor (FSEC) and its sub-contractors to have at least 5 years' experience in this type of work. Upon request provide at least three references for jobs of similar size and content.
 2. Commercially manufactured equipment is not acceptable unless evidence furnished that similar equipment has been operating successfully in a minimum of three (3) installations (excluding testing laboratories, field-testing or prototypes) for at least one (1) year.
 3. Commercially manufactured equipment will be reviewed based on submittal data provided on manufacturer's literature and/or manufacturer's shop drawings for prime alternate or substituted items. Failure of the equipment to meet the capacity, operation, size, utility and production as submitted will result in the rejection of the equipment regardless of disclaimers.
 4. Custom-fabricated equipment shall be manufactured by a foodservice equipment fabricator with at least five (5) years' experience in this type of work, who has the plant, personnel, and engineering facilities to properly design, detail and manufacture high quality foodservice equipment.
- B. Requirements of Regulatory Agencies:
1. NSF Compliance: All equipment subject to NSF approval shall be so labeled, or shall be constructed in accordance with applicable published NSF standards.
 2. Refrigerating Equipment: Conform to all applicable ASHRAE Standards. Evaporators NSF approved; electrical components UL (or ETL) approved.
 3. Electrical Equipment: Equipment shall carry UL (or ETL) approval and comply with applicable standards of the National Electric Code. Where specified, items shall be UL approved as a unit; if not, specified component electrical parts shall be approved separately. Where applicable, equipment shall comply with NEMA and NBFU standards. Where local regulations permit, a certified test report by an approved nationally recognized independent testing organization establishing proof of conformance to the standards, including test methods of UL, will be considered in lieu of UL label.
 4. Civil Authorities: Comply with all ordinances, codes and regulations of civil authorities having jurisdiction at Job Site.
 5. Sheet Metal Fabrication: Comply with NFPA standard No. 51: "Welding and Cutting"; and applicable NSF standards.
 6. ADA Compliance: Installation and construction of equipment and furnishings to comply with the American Disabilities Act as described in the Department of Justice Register Volume 56, No. 144.
 7. Seismic Installation: SMACNA compliant anchoring, restraining and seismic attachments.

1.6 GUARANTEE AND WARRANTY

- A. All equipment shall be fully guaranteed against defects in workmanship and material for one (1) year after Owner's final acceptance. All repairs and replacements shall be made without charge to the Owner. Guarantee period shall commence with the first usage of the equipment for the intended purpose after final acceptance. Also see additional guarantee required for refrigeration equipment.

1.7 EQUIPMENT ACCESS

- A. Verify all building conditions and coordinate proper access of large equipment to the building. Any specific items needed for the movement of large, heavy or bulky equipment is the full responsibility of the Contractor.

1.8 SUBMITTALS

- A. Contractor to submit two (2) bond print for review, after which, Contractor will receive one (1) of the reviewed sets for printing and distribution. All submittals; Shop Drawings, Rough-In Drawings and Equipment Brochures, must be delivered as one complete package.
- B. Shop Drawings:
 - 1. Shop drawing of all custom fabricated equipment shall be submitted at 3/4 inch scale. All custom fabrication shall have dimensions, fabrication, materials, thickness, and details of construction, installation and method of field joint. Shop details indicate reinforcements, methods of anchorage and quality of finishing.
 - 2. Verify all field dimensions and incorporate them into shop details.
- C. Rough-in Drawings: Rough-in drawings shall be submitted and show every piece of equipment, all dimensions for rough-in points for electrical, plumbing, steam, exhaust, gas, refrigeration, beverage conduits, as well as concrete curbs, sleeves, supports and any core drilling required. Check and confirm that all equipment requirements have been shown in contract documents, included in rough-in drawings and coordinated with specified, alternate and/or substituted equipment being provided.
- D. Equipment Brochures: Assemble and bind Equipment Brochure books as part of submittal. All equipment cut sheets shall clearly show all specified accessories, utility requirements and any other pertinent information; four (4) required.

1.9 START-UP DEMONSTRATION AND MANUALS:

- A. Provide factory-trained engineers for start-up and demonstration of equipment. Demonstration shall be done in two stages: One for operation and the second for maintenance personnel.
- B. Return to the job site within 10 days for final adjustment and calibration of equipment.
- C. Furnish service parts manuals as well as maintenance manuals.
- D. Prepare list of service agencies authorized by the manufacturer to service its equipment. Include the name of the person to contact and a telephone number.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS OF FABRICATION

- A. Fabrication shall conform to general acceptance of the foodservice industry.
- B. Fabrication shall meet or exceed National Sanitation Foundation standards including the latest editions and revisions.

2.2 MATERIALS

- A. Stainless Steel (S/S): Stainless steel shall be of U.S. Standard-gauges as indicated, but not less than 18-gauge or as noted, Type 304 with No. 4 finish.
- B. Galvanized Steel: Galvanized steel shall be of 14-gauge and shall be electro galvanized. Galvanized steel shall be used in non-exposed areas, areas, which have no contact with food or food serving items and in framework, when used in framework, galvanized steel shall be, welded construction.

2.3 METAL TOP CONSTRUCTION

- A. Metal tops shall be one-piece 14-gauge welded construction, including field joints. Secure to a full perimeter galvanized steel channel frame cross-braced not farther than 30 inches on center. Fasten top with stud bolts or tack welds. All exposed leading top edges to have "highlighted" #8 finish.

2.4 ENCLOSED CABINET BASES

- A. Bases shall be fabricated from not less than 18-gauge steel reinforced by forming the metal ends and shelves. Partitions shall be all of stainless steel. The ends and vertical partitions may be of single wall construction, with a 2-inch face, all partitions and sides shall be welded in the intersection and flush with the bottom.
- B. Unexposed backs and structural members may be constructed of galvanized steel.
- C. Intermediate shelves shall be removable, except the bottom shelf when the cabinet is on legs. When the cabinet is on a masonry base, the bottom shelf shall be removable to allow access for cleaning.

2.5 LEGS AND CROSS RAILS

- A. Legs and cross railings shall be 1-5/8-inch, 16-gauge stainless steel tubing. All cross rails shall be continuously welded, grounded and polished. Tack welds or other methods of connection are not acceptable. Bottoms of legs shall be wedged inward and fitted with a stainless steel bullet type foot with not less than 2-inch adjustment. Freestanding legs shall be pegged to floor with 1/4-inch stainless steel rod.
- B. Stainless steel gusset shall be not less than 3-inch diameter at top and 3-3/4-inch long. Outer shell 16-gauge stainless steel reinforced with 12-gauge mild steel inserts welded interior shell. Gusset shall be large enough to accommodate 1-5/8 inch tub with provision for Allen screw fastener.
- C. Low counter leg shall be constructed of stainless steel exterior of 5-3/4 inch minimum height or 7 inch maximum height with 3-1/2 inch square plate with four countersunk holes, welded to the top for fastening.

- D. Adjustable foot shall be constructed of stainless steel 1-1/2 inch diameter tapered at the bottom to 1-inch diameter, fitted with treaded cold rolled rod for minimum 1-1/2 inch by 3/4-inch threaded bushing plug welded to legs.
- E. When legs are fastened to equipment, the following methods should be used.
 - 1. Sinks: Reinforced with bushings and set screws.
 - 2. Metal Top Table or Dishtable: Welded to galvanized steel frame of 14-gauge or more and secure to the top with screws through slotted holes.
 - 3. Wood or Composition Top: A welded stainless steel channel of not less than 14-gauge, secured to the top with screws through slotted holes.

2.6 SHELVES

- A. When shelves are part of the fixture, the following shall take place.
 - 1. Open base type shelf shall be notched around the leg and continuously welded to the leg.
 - 2. Cabinet base type shelf shall be turned up on the back side a minimum of 1/4 inch radius and further slightly to insure a tight fit to enclosure panels.
- B. Wall shelves shall be one-piece 16-gauge welded construction, including field joints. Secure walls with 14-gauge S/S brackets at 36-inch on-center maximum. All exposed leading edges to have "highlighted" #8 finish.
- C. Over-shelves shall be one-piece 16-gauge welded construction, including field joints. Secure to 1-inch tubular supports at 60-inch on-center maximum attached to counter tops.

2.7 SINKS

- A. When multiple compartments are part of the design, they shall be continuous on the exterior without applied facing strips or panels. Bottoms of each compartment shall be creased such as to ensure complete drainage to waste opening.
- B. Partitions between compartments shall be double thickness continuous and welded.
- C. Where sink bowls are exposed, the exterior shall be polished to a number 4 finish.
- D. Fabricator shall provide drains, wastes and faucets as indicated on drawings, or itemized specifications

2.8 OTHER FABRICATED COMPONENTS

- A. Casters:
 - 1. Shall be heavy-duty type, ball bearing, solid or disc wheel with non-marking greaseproof rubber, neoprene or polyurethane tire.
 - 2. Wheel shall be 5-inch diameter, minimum width of tread 1-1/2-inch, with a minimum capacity per caster of 250 pounds.
 - 3. Solid material wheels shall be provided with stainless steel rotating wheel guards.
 - 4. Shall be sanitary, have sealed wheel and swivel bearings and polished plate finish.
- B. Doors:
- C. Metal doors shall be double cased stainless steel. Other pans shall be 18-gauge stainless steel with corners welded, ground smooth, and polished. Inner pan shall be 20-gauge stainless steel fitted tightly into outer pan with a sound deadening material such as Celotex

or Styrofoam used as a core. The two pans shall be tack welded together and joints solder filled. Doors shall finish approximately 3/4-inch thick and be fitted with flush recessed type stainless steel door pulls.

1. Sliding doors shall be mounted on large, quiet ball bearing rollers in 14-gauge stainless steel overhead tracks and be removable without the use of tools. Bottom of cabinet shall have stainless steel guide pins and not channel tracks for doors.
2. Wood doors shall be fabricated as detailed. If Formica or other plastic surfaces are used, all sides shall be laminated.
3. Hinged doors shall be mounted on heavy-duty N.S.F. approved hinges, or as noted on plans or specifications

D. Hardware:

1. Shall be solid, heavy-duty type.
2. Door hardware shall be locking type, keyed and master keyed.
3. Shall be identified with manufacturer's name and number so that broken or worn parts may be replaced.
4. Submit samples for approval, when requested.
5. Pulls shall be Component Hardware or equal.

2.9 FABRICATED WORKMANSHIP

A. Items of specially fabricated equipment shall be fabricated by an acceptable manufacturer, which is N.S.F. approved and fabricated in an approved manner to the complete satisfaction of the Owner.

1. Welding and Soldering:
2. Materials 18-gauge or heavier shall be welded.
3. Seams and joints shall be shop welded or soldered as the nature of the material may require.
4. Welds shall be ground smooth and polished to match original finish.
5. Where galvanizing has been burned off, the weld shall be cleaned and touched up with high-grade aluminum paint.

B. Fasteners and Joints:

1. The following will not be accepted:
2. Exposed screw or bolt heads.
3. Rivets.
4. Butt joints made by riveting straps under seams and then filled with solder.

C. Rolled Edges: Rolled edges shall be as detailed, with corners bull nose, ground and polished.

D. Coved Corners: All stainless steel foodservice equipment shall have 1/2-inch or larger radius coves in all horizontal and vertical corners and intersections per N.S.F. standards.

E. Closures: Where ends of fixtures, splashback, shelves, etc. are open, fill by forming the metal, or weld sections, if necessary, to close entire opening flush to walls or adjoining fixtures.

2.10 OPERATION REQUIREMENTS

A. Insure quiet operation of foodservice and related equipment.

B. Insure the bumper gaskets stop and any other needed protection is installed on all fabricated equipment as needed.

2.11 EXHAUST HOODS

- A. Install assemblies in the location as indicated on drawings. It is the responsibility of the Installer to verify all clearances and stand offs from the hood to limited-combustibles and/or combustible materials. Hood must be installed in accordance with the Manufacturer's specifications. Canopy Hoods to be installed a minimum of 80 inches above the finished floor.
- B. The hood assembly ends to be fabricated from 16 gauge stainless steel or heavier and have a continuous horizontal Performedge shape at the lower most part of the end. The remainder of the hood will be fabricated of material not less than 18 gauge. All exposed surfaces to be fabricated from Type 304 stainless steel with a #4 finish. All exposed welds to be ground smooth and polished to a #4 finish.
- C. Provide matching stainless steel closure panels to finished ceiling, adjacent walls and spaces between hoods as required.
- D. Rear and side 3" air space(s), if required must be full height of hood assembly and enclosed top, bottom and sides.
- E. Hood assemblies must be manufactured UL 710 Listed, NFPA 96 compliant and installed in accordance with all prevailing codes and standards.
- F. Grease drip tray and container:
 - 1. Full length concealed grease drip tray, kept to the minimum size needed to collect grease below the filters pitched to drain to a fully enclosed metal container with a capacity of less than 1 gallon. For Hoods that exceed 96" provide enclosed metal container on each end of the trough.
 - 2. Grease collection container(s) may not protrude below the bottom of the hood.
 - 3. Entire length of the grease drip tray to be accessible for easy cleaning.

2.12 FIRE PROTECTION SYSTEM

- A. The fire protection system must be UL 300 Listed , NFPA 17A compliant and installed in accordance with all prevailing codes and standards.
- B. Provide all surface appliance, duct and plenum protection nozzles.
- C. All exposed piping to be stainless steel, chrome plated or sleeved. Run unexposed wherever possible.
- D. All piping must be installed by the Exhaust Hood manufacturer, no exceptions.
- E. No horizontal piping or exposed fasteners within the canopy.
- F. Manual pull station, location as shown on drawings.
- G. Assembly shall contain four (4) sets of normally open/closed contact points.
- H. Provide fuel gas shut off valve and electrical reset relay when required for equipment below hoods. Verify size with Plumbing Division.
- I. Upon completion the system must be tested and tagged in the presence of the enforcing agency.

2.13 ENCLOSURES

- A. Provide and install enclosure panels secured or removable for any equipment that houses any equipment with movable parts for access. Also, cover and provide protection for any exposed steam line or condensate line that may be within reach of operating personnel.

2.14 ELECTRICAL WORK - GENERAL REQUIREMENTS

- A. Before ordering equipment, confirm with the serving electric utility, all pertinent electrical requirements such as actual voltages available, number of phases and number of wires in the system. Coordinate also with any electrical service provide with other Divisions.
- B. Components and assemblies shall bear the U.L., RU or ETL label or be approved by the prevailing authority.
- C. Custom fabricated and standard refrigerator units shall be provided with vapor tight receptacles, shatterproof lamps and automatic switches. All wiring shall be concealed when possible.

2.15 INSERT PANS

- A. All cut-outs, openings, drawers, or equipment specified or detailed to hold stainless steel insert pans shall be provided with a full complement of pans as follows:
 - 1. One stainless steel, 20-gauge minimum, solid insert pan for each space, sized per plans, details or specifications.
 - 2. Where pan sizes are not indicated in plans, details or specifications, provide one full size pan for each opening.
 - 3. Provide maximum depth pan to suit application and space.
 - 4. Provide 18-gauge removable stainless steel adapter pans where applicable.

2.16 CORDS AND PLUGS

- A. Where cords and plugs are used, they shall comply with National Electrical Manufacturer's Association (N.E.M.A.) requirements.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION OF EQUIPMENT

- A. Supervision: A competent superintendent, representing the Contractor shall be present during progress of the work.

3.2 TRIMMING AND SEALING EQUIPMENT

- A. Any space between units to walls, ceilings, floors and adjoining units, not portable, shall be completely sealed against entrance of food particles or vermin by means of trim strips, welding, soldering, or commercial joint material suitable to the nature of the equipment.
- B. Sealer, when not exposed to extreme heat, shall be silicone construction sealant in appropriate color.
- C. Ends of hollow sections shall be closed.
- D. Enclosed fixtures without legs mounted on masonry bases or floor shall be sealed watertight to base or floor.

3.3 CUTTING AND FITTING

- A. Cutting and fitting required on the equipment by subcontractors to make their work fit.
- B. Should any repairs to foodservice equipment be required due to neglect of other contractors, all extra charges and all anticipated repairs shall be noted in writing before work is performed. In case this Contractor does not follow this procedure, the expense shall be borne by him.
- C. No cutting, notching, drilling, or altering of any kind shall be done to the building without first obtaining permission.

3.4 PROTECTION OF EQUIPMENT

- A. Be responsible during the progress of the project to protect equipment against theft and/or damage until final acceptance.
- B. Prefabricated walk-in boxes, on-site and installed in advance of the rest of the equipment, shall not be used for general storage by other trades and shall be locked before leaving the site. Damage and/or theft resulting from failure to secure boxes will be repaired/replaced at Contractor's expense.

3.5 ITEMIZED EQUIPMENT LIST

ITEM 1: REFRIGERATOR
Contractor Furnish – Contractor Install

Manufacturer: Victory
Model: RS-2N-S1
Alternate: Traulsen

- 1. Doors hinged as shown on plan.
- 2. Seismic leg set.
- 3. Top and rear panel covers, slotted, stainless steel.
- 4. Tamper proof grille kit.
- 5. Cam-lock hinges with tamper proof screws.
- 6. Padlock hasp.

ITEM 2: HAND SINK / SIDE SPLASH
Contractor Furnish – Contractor Install

Manufacturer: Custom Fabricated
Model: See Elevations
Furnish and set-in-place in accordance with Part-2 Products, Plans and Details.

- 1. T&S B-1110 faucet and crumb cup waste assembly.

ITEM 3: BACK COUNTER WITH SINKS
Contractor Furnish – Contractor Install

Manufacturer: Custom Fabricated
Model: See Elevations

Furnish and set-in-place in accordance with Part-2 Products, Plans and Details.

- 1. T&S B-0201 faucet and two (2) crumb cup waste assemblies.

ITEM 4: OPEN BURNER RANGE
Contractor Furnish – Contractor Install

Manufacturer: Vulcan
Model: VHP636
Alternate: Jade Range, Montague

Furnish and set-in-place in accordance with Part-2 Products, Plans and Details.

1. Gas pressure regulator.

ITEM 5: COOKING COUNTER

Contractor Furnish – Contractor Install
Manufacturer: Custom Fabricated
Model: See Elevations
Furnish and set-in-place in accordance with Part-2 Products, Plans and Details.

ITEM 6: MICROWAVE

Contractor Furnished – Contractor Installed
Manufacturer: ACP Amana
Model: RCS10DSE
Alternate: Panasonic

ITEM 7: EXHAUST HOOD (TYPE-I)

Contractor Furnish – Contractor Install
Manufacturer: Streivor Air System
Model: ISFL-CR 200 54 48 30
Furnish and set-in-place in accordance with Part-2 Products, Plans and Details.

1. Length, width and configuration per plan, elevations and field conditions.
2. Confirm assembly meets front, side or back overhang requirement per code for capture and containment.
3. Hood assembly to be fitted with ExtractAire HVC UL1046 Listed high velocity adjustable slot Cartridge Filters and meets the following construction requirements:
 - a. Opening at the upper most portion of the top allow air to enter into the filter. Opening to be located within 5" of the top of the hood and be fitted with an adjustable air diverter and choke to control airflow through the cartridge.
 - b. Designed to force the air traveling through the cartridge to change direction a minimum of five times and 180 degrees.
 - c. Bottom of filter to be entirely open to allow grease to flow freely out of the cartridge and facilitate hand or dishmachine cleaning and be easily removable without the use of tools.
 - d. Grease efficiency rating of 55% or higher as certified by an independent testing laboratory and procedure recognized by ASHRAE TC-510.
 - e. Type 304 stainless steel polished to a #4 finish.
4. Hood assembly to be fitted with UL & NSF Listed Surface Mounted Commercial Kitchen Hood light fixtures with lamps.
 - a. Fixture to have brushed aluminum housing, tempered glass, and shatter resistant globe.
 - b. Light fixture(s) to be factory pre-wired to a single connection point for each hood section.
 - c. LED lamp, 120vac, UL Listed for exhaust canopy hoods, 12 Watt, 960 Lumens, 3000K, maximum operating temperature 80 degrees C (176°F).
 - d. 120 degree Beam angle, rated for 50,000 hour lamp life, mercury-free, instant (no ballast).
 - e. To exceed Federal Energy Act requirement as to not produce ultraviolet light emission.
 - f. Fits any A19/E26/E27 fixture (globe to be installed in compliance with UL listing).
5. Hood to be fitted with a UL710 Listed, internally adjustable opposed blade variable volume damper(s).
 - a. Opposed blades to include a positioning bracket that allows the damper blades to be adjusted from 5% to 100% open.
 - b. Each positioning bracket to have a locking/unlocking fastener on the inside of the damper that is accessible from inside of the hood that locks the damper blade in place.
 - c. Damper to be manufactured from 18 gauge stainless.
6. Hood assembly to be provided with an Auto Fan Start is required for NFPA 96 Section 8.2.3.3
 - a. Switches may be located in each hood exhaust collar or the hood canopy section.
 - b. Switches in each canopy to have a maximum spacing of 84 inches.
 - c. Switches to be installed in Access Enclosure(s) with a removable cover plate that protects and allows access from inside of the hood canopy.

7. Hood assembly be fitted with UL 710 listed Access Enclosure(s) mounted in the Hood Canopy or Hood Exhaust Collar with a removable cover plate that protects and allows access to monitoring equipment from inside of the hood canopy.
 - a. Removable cover to be held in place by stainless steel fasteners and allows easy access for installation, adjustments and service to the equipment from inside of the hood canopy.
 - b. Access Enclosures to be fabricated from 18 gauge stainless steel with all welds ground smooth and polished to a #4 finish.
8. Hood Utility Cabinet (HUC) assembly mounted to end of Hood assembly per plan.
 - a. HUC to house Pyro-Chem Fire Suppression System.
 - b. Constructed with angle iron frame and stainless steel body.
 - c. All exposed surfaces to be fabricated of 18 gauge Type 304 stainless steel (s/s) with a #4 finish.
 - d. All exposed welds to be ground smooth and polished to a #4 finish.
 - e. Cabinet provided with open top to enable utility connections from above ceiling and a stainless steel lift out removable side door panel.
 - f. Removable door panel to have a recessed s/s door pull, full grip type and held in place by full length upper and lower channels.

ITEM 8: FIRE SUPPRESSION SYSTEM
Contractor Furnish – Contractor Install
Manufacturer: Streivor Air Systems
Model: HUC/Pyro-Chem Kitchen Knight II
Alternate: Pyro-Chem, Kidde

Furnish and set-in-place in accordance with Part-2 Products, Plans and Elevations.

1. Electrical gas valve, provided to and installed by Mechanical Division, verify size.
2. No exposed horizontal piping.
3. Exposed vertical piping to be chromed.
4. FSEC to provide separate permit and testing for the local fire life safety inspector.
5. Provide four (4) additional sets of contacts.
6. System to protect Item 102 - Exhaust Hood and equipment installed below.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Basketball equipment and accessories.

1.2 QUALITY ASSURANCE

- A. Installer's Qualifications: Installation shall be by manufacturer's authorized representative employing skilled mechanics thoroughly trained and experienced in this type of installation and who are completely familiar with the requirements of the work specified.
- B. All material and equipment shall be furnished by manufacturers regularly engaged in production of these items. Manufacturer's recommendations shall be followed in all cases for installation and conditions.
- C. Comply with all local, State or Federal codes and regulations. Manufacturer and manufacturer's representative shall have a minimum of prior ten successful jobs, similar in scope.
- D. For convenience in identifying equipment items, manufacturer's catalog numbers are scheduled. Unless modified by Specifications or notation on Drawings, catalog description for indicated number shall constitute basic requirements for each item. Equipment shall incorporate all features set forth in catalog for standard item, except for such modifications thereto as may be indicated.
- E. Provide manufacturer's standard one year warranty. Backboards provided with center strut attachment to have manufacturer's limited lifetime warranty. Goals shall have manufacturer's limited two year warranty.

1.3 SUBMITTALS

- A. Shop drawings shall include engineering design calculations and shall clearly show all pertinent dimensions, data, sizes and fastening requirements. Calculations to be provided by a Structural Engineer, currently licensed in the State of California.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver to project site in manufacturer's original, unopened and undamaged packaging. Store in original packaging under protective cover and protect from damage. Handle materials in such a manner as to prevent damage to products or finishes.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design: Porter Athletic Equipment Co.
- B. Draper, Inc.
- C. Or Accepted Equal.

2.2 WALL MOUNTED BACKSTOP WITH BACKBOARD AND GOAL

- A. Porter Model No. 234A.
 - 1. Backboard: Aluminum fan board shall be official size (54 by 39 inches) and shape, with orange perimeter and target area markings. Perimeter flange and structural rib pattern shall be 1-1/2 inch deep. Tensile strength of board shall be 8,900 – 11,700 psi. Goal mounting shall be reinforced with a 3/16 inch by 6 inch wide plated steel plate secured to backside of board. Eight 3/8 – 16 stainless steel threaded inserts shall be molded into backside of backboard at standard mounting centers.
 - 2. Goal: Double rim, continuous net support and heavy-duty side and center support gusset plates. Double rim shall be formed to an official 18 inch inside diameter with 5/8 inch diameter solid cold rolled steel bars. Rims shall be further supported by a continuous 3/16 inch by 1 inch steel net tie strip. Net support shall be precision die cut with twelve net attachment opening to eliminate breakage associated with conventional type wire formed net tie clips. Rims shall be supported by a heavy mounting backplate with formed side plates tangentially connecting into the net support strip for maximum strength. Center reinforcing steel gusset shall provide additional rim support. Mounting backplate shall be slotted to provide universal mounting centers from 5 by 5 inches to 5 by 4 inches. Orange powder-coat finish. Provide Grade 5 carriage bolts, mounting hardware and heavy-duty chain net.

PART 3 EXECUTION

3.1 CONDITION OF SURFACES

- A. Examine all framing, grounds, and blocking required to secure backstops. Coordinate work of this section with work of other Sections to assure proper location of all solid blocking. Do not proceed with the work of this Section until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install all products specified in this Section per the manufacturer's recommendations.
- B. Backstops shall be installed and fastened in place in accordance with manufacturer's printed instructions and with Title 24, Part 2, CCR.
- C. Final Adjustment: Check backstop installation for correct rigidity of main frame installation. Any movement not permitted by the manufacturer shall be additionally braced to comply with the manufacturer's permitted tolerances.
- D. Defective Work: Remove and replace all defective work that cannot be properly repaired, cleaned or touched-up, with no additional cost to the County.
- E. Protect the installed work against damage from other construction.

3.3 CLEAN UP

- A. Upon completion of the work of this section, remove all surplus materials, rubbish and debris from the premises.
- B. Cleaning and Finishing: Upon completion, clean all exposed surface, removing any discoloration or foreign matter. Touch-up abraded or cut areas and exposed edges with finishing material recommended by the manufacturer. Touch-up shall not be obvious.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Detention hollow metal doors, frames, panels, windows, and sidelites, rated and non-rated.
- B. Embedded anchor devices.
- C. Electrical conduit and wire as specified in this Section only. Conduit and junction boxes occurring within panels, doors or frames are to be installed by this Section.
- D. Miscellaneous items, appurtenances and devices incidental to or necessary for a sound, secure and complete installation.

1.2 REFERENCES

- A. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- B. Referenced Standards:
 - 1. ASTM A36/A36M – Standard Specification for Carbon Structural Steel.
 - 2. ASTM A307 – Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - 3. ASTM A615 – Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
 - 4. ASTM A653/A653M – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - 5. ASTM A1008/A1008M – Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
 - 6. ASTM A1011/A1011M – Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
 - 7. ASTM C476 – Standard Specification for Grout for Masonry.
 - 8. ASTM F1450 – Standard Test Methods for Hollow Metal Swinging Door Assemblies for Detention and Correctional Facilities.
 - 9. California Code of Regulations, Title 24, Part 12, 2013 California Referenced Standards Code – Chapter 12-7-4, Fire-Resistive Standards.
 - 10. FS FF-S-325 – Expansion Anchors and Anchor Bolts.
 - 11. FS QQ-A-325 – Finish for Wedge Type Expansion Anchors.
 - 12. FS QQ-Z-325C – Plating of Anchorage Components. B. Stainless Steel Anchor Bolt Standards.
 - 13. FS TT-C-490 – Cleaning Methods for Ferrous Surfaces and Pretreatments for Organic Coatings.
 - 14. FS TT-P-664 – Primer Coating, Alkyd, Corrosion-Inhibiting,

Lead and Chromate Free, VOC-Compliant.

15. NFPA Standard No. 80 – Standard for Fire Doors and Other Opening Protectives.
16. UL – Underwriters Laboratory.

1.3 SUBMITTALS

- A. Submit complete shop drawings for fabrication, erection and installation of all items of detention equipment. Include plans, elevations and large-scale details. Show anchorage and accessory items and include electrical junction boxes, conduit and wiring locations and connections, to insure a complete and proper installation. All shop drawings shall be referenced to Architect's Door Schedule, Glazing Schedule, Detail Numbers, and Hardware Group as applicable.
- B. Submit product data under provisions of Division 01.
- C. Submit manufacturer's product data and installation instructions for each standard equipment and hardware item.

1.4 OPERATION AND MAINTENANCE DATA

- A. Submit operation data under provisions of Division 01.
- B. Detention equipment manufacturer shall furnish operating and specifications manuals for all detention hardware and all detention locking devices and provide instruction for the care of finishes and materials.
- C. Detention equipment manufacturer shall, upon notice of the Architect and without additional cost to Owner, provide factory representatives specifically trained in operation of detention equipment with a thorough knowledge of its mechanisms, for a five working day instruction and training period. Factory representatives must be capable of training custodial personnel in operation, repair and upkeep.

1.5 QUALITY ASSURANCE

- A. Detention equipment suppliers shall be pre-qualified by the Owner and provide the following information:
 1. List the last five jobs completed along with the Owner's and General Contractor's names.
 2. Show proof of completed schedule on past jobs.
- B. Manufacturer: Provide detention equipment products and items produced by manufacturers who have sufficient documented experience in manufacturing equipment for maximum security and medium security installation.
- C. Provide products of same manufacturer for each type of items or unit required. Provide each item as a unit, complete with all accessories, fittings, fastenings, anchorage, and devices necessary for items to correctly function for purpose for which intended.
- D. Installation shall be performed by manufacturer or his authorized representative under the manufacturer's direct supervision.
- E. Field Examination:
 1. At the direction of the Architect, the Contractor shall destroy a randomly selected security hollow metal door or panel by sawing it in half.

- a. Test reports and documentation shall be in accordance with ASTM F1450.
2. If the examination reveals that the construction is in variance with the details or specifications, the door manufacturer shall replace all doors shipped to the project, as of the date of examination, with new doors constructed in conformance with the specifications. Under conditions of non-conformity, the door manufacturer shall pay for the destroyed door, related labor and all replacement costs.
3. If the door was constructed in conformance with the specifications, the Owner shall pay for the replacement of the destroyed door and the related labor.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver products to site under provisions of Division 01.
- B. Deliver detention and security equipment cartoned or crated to extent feasible.
- C. Store in a protected location under cover with locks, operating and electrical devices in a securely locked room.
- D. Store larger items on wood blocking under cover and out of the weather.

1.7 REGULATORY REQUIREMENTS

- A. Wherever a fire-resistance classification is scheduled for a detention metal frame assembly, provide fire-rated metal frame assembly (complete with all products required) investigated and tested as a fire door assembly, complete with type of hardware to be used.
- B. Identify each fire door and frame with mylar UL labels, indicating applicable fire rating of door and frame.
- C. Construct and install assemblies to comply with NFPA Standard No. 80, and as herein specified.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers:
 1. Titan Steel Door – Murrayville, GA.
 2. Trussbilt – Vadnais Heights, MN.
 3. Sweeper Metal Fabricators Corp. – Drumright, OK
 4. Willo Products Company – Decatur, AL.
 5. Claborn Manufacturing Company (formerly Slate Security) – Hartsell, AL.
- B. Substitutions: Under provisions of Division 01 and Section 11 19 00.

2.2 MATERIALS

- A. Fastening Devices:
 1. All exposed screws and nuts shall meet ASTM A307 – Grade A.
 2. In areas where it is necessary to remove items from time to time, screws

shall have slots or holes that require a special tool for removing same and must be such that standard tools will not fit.

3. Each type of fastener must be indicated on shop drawings.
 4. All exposed screw fasteners shall be installed with Loctite, or accepted equal thread locking adhesive/sealant.
- B. Anchorage Devices:
1. Weld Studs: TRW Division "headed" studs; weld to steel plates.
 2. Wire Anchors: ASTM A615 grade 40 deformed rebar; weld to 10 gauge steel plates formed as required.
 3. Steel Plate Anchors: Galvanized steel sheets formed as required; thickness, sizes as indicated.
 4. Steel Plates: ASTM A36/A36M steel; form as required.
 5. Expansion Anchors: FS FF-S-325 Group II, Type 3, Class 3 plated finish. Provide each anchor complete with bolt, expansion sleeve, hex nut, washer; 1/2 inch diameter size required with length as required for 4 inch minimum embedment depth, except where indicated to be longer.
 6. Anchor Bolts Concealed From View: FS FF-S-325 Group II, Type 4, Class 1 wedge-type expansion anchors with FS QQ-Z-325C Type 1, Class 3 plated finish. Provide each anchor complete with bolt, expansion sleeve, hex nut, washer; 5/8 inch diameter size required with length as required for 2-3/4 inch minimum embedment depth.

2.3 DETENTION HOLLOW METAL DOORS AND PANELS

- A. Construct of commercial quality, leveled, cold-rolled face sheets, ASTM A1008/A1008M, with interior vertical full-height steel reinforcing channels at 6 inches on center. Spot weld face sheets to each reinforcing channel at 3 inches on center maximum. Fill spaces between channels with mineral rock wool filler, six pound density. Exterior doors shall be galvanized to ASTM A653/A653M A60. Note: Manufacturer's standard alternate interior door reinforcing may be acceptable. Submit complete information and details for approval in compliance with provisions of Division 01.
- B. Doors and panels to be full flush design, 2 inches nominal thickness, sizes, type and elevations as shown on Drawings, schedules and approved shop drawings.
- C. Metal Gauges:
1. Face Sheets:
 - a. Medium Security: 12 Gauge
 2. Vertical Reinforcement:
 - a. Medium Security: 12 Gauge
- D. Door Edges: Bevel vertical door edges 1/8 inch in 2 inches, reinforce full height with steel channels 1/8 inch thick, welded to both door faces at 3 inches on center maximum. Top and bottom reinforced full width with 10 gauge channels welded to vertical edge channels and to both door faces at 3 inches on center maximum. All edges shall be finished flush.
- E. Openings in Doors: In maximum security doors and panels, all openings shall be reinforced to match door edges.

- F. Maximum clearances between doors and frames:
1. 1/8 inch at head.
 2. 1/8 inch at jamb.
 3. 1/8 inch at vertical meeting edge of pairs of doors.
 4. 5/8 inch under non-rated door with no threshold.
 5. 5/8 inch under fire rated door with no threshold.
 6. 5/8 inch under door with threshold.
- G. Provisions for Hardware:
1. Mortise, cut, reinforce, drill and tap door edges to receive approved hardware. Comply with hardware manufacturer's recommendations and instructions.
 2. Provide reinforced pocket to receive mortised locks. Protect lock with steel plates welded inside of door faces; 1/8 inch thick plates at medium security.
 3. Provide reinforced seats, 1/8 inch and 3/16 inch thick, drilled, tapped and set back to the thickness of the face of the lock installed through door edge. Weld to edge channel. Cut away edge reinforcing channel only as necessary to pass the lock. Provide lock centering clips on each side of lock pocket. Cut out faces to pass cylinders, etc.
 4. Provide a special pocket where prison locks are installed through the face of door: 3/16 inch thick steel reinforcing plate welded inside the detention side of pocket. Cut away outside face for lock installation. Secure lock to 3/16 inch steel plate furnished by lock manufacturer as per manufacturer's details. Frame around pocket to allow this plate to finish flush with surface of door. Secure plate with minimum of eight 1/4 inch security screws. Removal of lock shall be impossible when lock bolt is extended.
 5. Cut hinge edge reinforcing channel only as necessary for mortise butts. At each hinge location, weld inside the edge channel a 3/16 inch x 1-1/2 inch x 10 inch reinforcing plate. At the top hinge location, reinforce with an additional channel welded to the plate inside the edge channel.
 6. Full Reinforcing: Steel plate, 3/16 inch x 1-1/2 inches x 10 inches, welded inside door.
 7. At all other surface hardware locations, reinforce with 14 gauge steel welded inside door.
 8. Electrical Items: Where electrical wiring passes through the door for electric locks, electric hinges or limit switches, the required junction boxes conduit or raceway shall be provided and factory installed by the door manufacturer. The electrical wiring shall be furnished, installed and connected in the field by the Detention Equipment Contractor.
- H. Openings in Doors:
1. All openings in doors shall be framed inside the door with 12 gauge minimum steel channels welded to both faces.
 2. Provide non-removable glazing stop on detention side.
 3. Provide pressed steel angle type glazing stops fastened with 1/4 inch diameter machine screws placed a maximum of 2 inches from ends of stops and a maximum of 6 inches on center.

- I. Factory Finish:
 - 1. Before Assembly: Clean and coat all surfaces with corrosion resistant iron oxide-zinc chromate primer.
 - 2. After Assembly: Grind, fill and sand all surfaces and edges, bonderize or phosphate treat, then coat all exposed surfaces with rust inhibitive primer.
- J. Hardware Installation:
 - 1. Factory installed hardware includes dead bolts, mortise locks, protection plates, flush bolts, push plates, kick plates, key escutcheons, head bolts, steel bolt pocket in door and all mortise hardware.
 - 2. Field installed hardware includes all projecting items such as pulls, knobs and handles. These items are installed by Detention Equipment Contractor.
- K. Performance Tests:
 - 1. Submit independent testing laboratory report on typical flush door. Include description of the test sample and all gauges of components.
 - 2. Certify the door supported at both ends sustains a load of 13,000 pounds applied at quarter points with a maximum mid-span deflection of 0.50 inch for 3 foot x 7 foot doors and maximum security doors.
 - 3. Certify the door fixed at one end and supported at one corner sustains a concentrated twisting force of 5,200 pounds applied to the unsupported corner with a maximum deflection of 2.55 inch for 3 foot x 7 foot doors and maximum security doors.

2.4 DETENTION PRESSED METAL FRAMES

- A. Provide pressed steel frames for doors, security type transoms, sidelites, borrowed lites, observation, visitation, control, and security windows.
 - 1. Exterior Frames: Commercial grade steel, 12 gauge, galvanized to ASTM A653/A653M A60.
 - 2. Interior Frames: Commercial grade cold-rolled steel, ASTM A1008/A1008M or commercial grade hot-rolled and pickled steel, ASTM A1011/A1011M, 12 gauge.
 - 3. All joints shall be fully mitered and continuously welded inside the miter across the full depth and width of the frame.
- B. Mullion and/or Rail Members: Closed tubular shapes with no visible seams or joints. Weld all abutting members.
- C. Furnish all frames as a single, complete unit where possible. Large frames may be furnished in sections with factory prepared splices. Show all field required splices and splice details on shop drawings.
- D. Provisions for Hardware:
 - 1. Mortise, reinforce, drill and tap at the factory for approved hardware. Comply with manufacturer's instructions and recommendations.
 - 2. For mortise butts, provide full height 3/16 inch x 1-1/2 inch steel reinforcing plate offset at each hinge location, factory drilled and tapped. At top hinge, add a 3/16 inch backup angle welded to offset reinforcement and to the inside of frame trim.

3. Follow manufacturer's recommendation for lock or keeper preparation. Reinforcement: 12 gauge for medium security, 1/8 inch thick for maximum security. Protect all cut-outs and reinforcement with pressed steel mortar guards inside the frame.
 4. Door closer reinforcement shall be 12 gauge one piece channel type, 2-1/2 inches deep by 14 inches long, actual configuration shall be verified with closer manufacturer.
 5. 1/8 inch thick reinforcing tabs for all mortise strike areas.
- E. Provisions for Electrical Locks:
1. Where electric locks occur in metal frames, the frame face and dimensions shall be modified as recommended by the lock manufacturer, as shown on the drawings, or if not indicated, then as follows:
 - a. Increase frame face width at the lock location to accommodate lock size or provide face width required to accommodate lock size or provide face width required to accommodate lock for full height of frame as indicated on drawings. Set face back to a frame depth of 3-13/32 inch minimum. Provide opening for face access installation on the non-secure side.
 - b. Enclose and form lock pocket with 14 gauge steel welded on all sides.
 - c. Provide lock mounting late at 3/16 inch steel inside the pocket welded to secure side of frame.
 - d. Provide 3/16 inch lock cover plate to close the face opening. Surface-mount the rounded edges. Fasten with twelve 1/4 inch #20 security screws.
 - e. Include the necessary holes for conduit, lock cylinder and other devices.
 - f. Electrical Items: All required junction boxes, conduit or raceway shall be provided and factory installed by door frame manufacturer. Factory install conduit in frame for electric power source to lock pockets and door position indicator switch. Install conduit from pocket vertically to top or bottom of frame. Verify location with electrical and electronics contractors for field conduit installation. Include conduit for communication intercoms located in frames. Coordinate size, locations and quantities required. The electrical wiring shall be furnished and installed in the field by electronics contractor with final terminations by Detention Equipment Contractor.
- F. Provisions for Field Grouting:
1. Openings in Frames: Provide openings in all abutting mullions to facilitate free flow of grout to all frame members. At field welded frames in precast concrete walls with weld plates, provide 1-1/4 inch diameter holes at head frames to facilitate field solid grouting of frames.
 - a. Grout shall conform to ASTM C476.
- G. Provide all frames with temporary spreader angles attached to the bottom and at the center hinge locations of both jambs.
- H. Glazed Openings in Frames:

1. Frames for glazed openings shall have non-removable stops on secure side and removable glazing beads on opposite side. Glazing beads shall be formed steel angles, size as shown on Drawings. Factory-drill beads for 1/4 inch diameter machine security screws at 2 inches maximum from each end and 6 inches maximum on center. Furnish all security screws and special tools.
 2. Frames shall be provided with 1 inch minimum glass engagement or greater as required by glazing manufacturer and non-removable stops on the detention side and removable glazing beads opposite.
 3. Glazing beads for medium security frames shall be formed steel channels to the depth shown, and of the same gauge as the associated frame. Glazing beads shall be factory drilled and countersunk for flat or oval head machine screws and shall be secured at the factory with slotted flat head machine screws.
 4. Center pin rejection (Torx) security machine screws and special screwdrivers shall be furnished by the frame manufacturer for use to install glass and glazing in the field.
 5. Where tool resistant (T.R.) bar passes through frame, ribs of bar shall be notched the thickness of material that bar passes through, and be rotated 90 degrees to form positive lock joint. Also, weld bar to frame where bar passes through.
 6. Frame rabbets shall be additionally reinforced to engage at least four threads of the stop or head fastening screws.
 7. Stop shall be painted to provide corrosion resistance on all surfaces including those concealed when stops or beads are in place.
 8. Install glazing tape between metal stops and glass units. Refer to Section 08 88 53 for acceptable manufacturers and products. Glazing tape shall not extend above top of stops.
- I. Security Framing for Control Room Framing and Miscellaneous Sidelites: Provide same material framing as specified above for security pressed metal frames with configurations and sizes as detailed on drawings.
- J. Intercom System: Where intercom speakers are required, factory-install junction boxes and required conduit in frames as per intercom manufacturer's recommendations. Verify size and placement and indicate these on the shop drawings.
- K. Frame Anchors: Locate jamb anchors at 8 inches from top and bottom and at 16 inches on center maximum. Locate head and sill anchors at 8 inches from ends and at 16 inches on center maximum where the masonry opening is 40 inches or greater.
1. Anchors at Masonry: 3/8 inch diameter wire anchor loops welded to the 10 gauge steel plates or steel straps welded to embedded steel anchor plates or angles.
 2. Anchors at Concrete: 3/8 inch steel straps welded to continuous embedded steel plate. Reinforce frame and anchors with 12 gauge steel plate.
 3. Anchors at Steel: 10 gauge zee welded to steel and frame.
 4. Floor Anchors: 10 gauge plate welded to frame with adjustable anchor leg.

5. Provide and install frame stiffener plates, made of 10 gauge bent steel, at 8 inches on center each way in all frames with over 6 inches continuous width or height (one piece).

2.5 FINISHING

- A. After assembly, smooth tool marks and surface imperfections by grinding, filling and sanding. Welded joints exposed to view and not continuously welded shall be filled with a metallic filler and ground smooth so as to show no exposed seam. This applies to both factory assembled and field assembled frame and detention equipment components.
- B. Clean surfaces thoroughly of rust, oil and other impurities and phosphate coat to condition the surface in accordance with Federal Specification TT-C-490.
- C. Coat all surfaces, both inside and outside the frame, to a minimum thickness of 1 mil with rust inhibitive red iron oxide-zinc chromate primer (equal to Federal Specification TT-P-664).

PART 3 - EXECUTION

3.1 INSPECTION

- A. Installer of detention equipment must examine the substrates, rough-ins and inserts related to installation of detention equipment and report in writing to the Contractor of conditions detrimental to the proper and timely installation of this work. Do not proceed until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

3.2 INSTALLATION

- A. Detention Equipment:
 1. Assemble units, which are not factory assembled. Set units in place and anchor to abutting construction as indicated and in accordance with final shop drawings.
 2. Hollow metal frames and frames in masonry construction shall be set in place, anchored, and grouted under Section 04 22 00. Contractor shall provide visual verification of solid grouting by observing the frames being grouted. Grout shall be installed until it is released out of verification holes in glazing pockets. Contractor shall clean grout off directly after to avoid damage to frames.
 3. Furnish inserts, anchors and templates for detention equipment that is to be built into concrete or masonry for installation under Section 03 30 00 and Section 04 22 00.
 4. Install units plumb, square, properly aligned and securely anchored. Provide anchors, trim and accessories required for a complete, secure and functional installation.
 5. Cut holes in detention equipment to accommodate plumbing lines as located by Plumbing Installer.
 6. Make field connections, as detailed on final shop drawings. Perform welding using certified welders and grind all welds smooth.
 7. Touch up welds and damaged areas with specified shop primer.

3.3 PROTECTION AND CLEANING

- A. Handle all fixtures, materials, assemblies and equipment to avoid injury to persons and to avoid damage to work in place. Satisfactorily repair or remove and replace work that has been damaged.
- B. Protect adjacent surfaces from damage and soiling.
- C. Clean work under provisions of Division 01.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Hardware for security doors.
- B. Gasketing.
- C. Accessories.

1.2 REFERENCES

- A. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- B. Referenced Standards:
 - 1. 2019 CBC – California Building Code.
 - 2. ADA – Americans with Disabilities Act - 2010 Standards for Accessible Design.
 - 3. ANSI A156 Series – Builders Hardware Manufacturers Association (BHMA) Standards Set.
 - 4. NFPA 80 – Standard for Fire Doors and other Opening Protectives.
 - 5. NFPA 101 – Life Safety Code.
 - 6. UL Building Materials Directory.
 - 7. UL 305 – Standards for Panic Hardware.

1.3 SUBMITTALS

- A. Submit product data identifying each item, installation instructions and general recommendations for proprietary products as required, including, but not limited to, hinges, lock mounts, closures, pulls, door position indicator switches, lock mount covers, bolt keepers, wall bumpers, weather-stripping, dead bolts, thresholds, escutcheons, door holders and door silencers.
- B. Submit complete shop drawings, including large-scale details; indicate anchorage, accessory items and required electrical junction boxes, conduit and wiring locations and connections. Failure to submit complete drawings will result in resubmittal.
 - 1. Hardware and Keying Schedules: Submit each schedule type; indicate products by name and number for each separate opening. Reference to Architect's Hardware Schedule Groups.
- C. Submit samples under provisions of Division 01
- D. Samples shall be furnished only upon request of Architect and prior to submittal of the last draft of the hardware schedule and prior to delivery of hardware; if requested, submit one sample of each hardware product, finished as required and tagged with full description for coordination with hardware schedule. Samples will be returned to supplier.

- E. Templates and Samples of Fabrication: Forward blueprint templates for each type of detention equipment hardware required to fabricators of work in Section 11 98 12 within two weeks following final review of hardware and keying schedules. Provide three sets of hardware items to each fabricator. Hardware items are to be actual stock of material to be used on this Project and may be used in the final installation if undamaged.

1.4 OPERATION AND MAINTENANCE MANUALS

- A. Submit operation/maintenance data in accordance with Division 01.
- B. Include special tools and operating equipment necessary for maintenance and repair of hardware.

1.5 QUALIFICATIONS

- A. Detention equipment suppliers not listed shall be pre-qualified by the Owner and provide the following information:
 - 1. List the last five jobs completed along with Owner's and General Contractor's names.
 - 2. Show proof of completed schedule on past jobs.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Cold Rolled Low Carbon Steel Sheet: ASTM A1008.
- B. Hot Rolled Low Carbon Steel Sheet: ASTM A568 and ASTM A1011, pickled and oiled.
- C. Plates and Bars: ASTM A29 or A283, Grade C.
- D. Steel Sections, Plates, Not Otherwise Indicated: ASTM A36.
- E. Stainless Steel: ASTM A240, Type 304, Austenitic.
- F. Galvanized Carbon Steel Sheets: ASTM A924 with ASTM A653 G90 Coating.
- G. Primer: USP/BHMA 600.

2.2 FINISHES

- A. Unless otherwise specified, finishes shall be as follows:
 - 1. BHMA 626 – Satin chromium plated brass or bronze.
 - 2. BHMA 628 – Satin or dull aluminum, clear anodized (uncoated).
 - 3. BHMA 630 – Satin stainless steel.
 - 4. BHMA 652 – Satin or dull chromium plated steel.
 - 5. BHMA 689 – Sprayed aluminum paint finish.

2.3 RECYCLED CONTENT

- A. Provide products with at least the following content:
 - 1. Hinges: 35 or more percent pre-consumer recycled content.

2. Locks: 50 or more percent post-consumer recycled content.
3. Closers: 50 or more percent post-consumer recycled content.
4. Kick Plates: 35 or more percent pre-consumer recycled content.

2.4 FIRE RATED DOORS

- A. Where hardware groups/sets have different information, refer to the following for clarification. Provide hardware groups/sets devices along with added devices as indicated on drawings and detailed requirements for each type of device. Provide all specifications even if not written in hardware sets/groups.
- B. Provide all hardware necessary to meet the requirements of CBC for fire doors and exit doors, as well as to other requirements specified, even if such hardware is not specifically mentioned under Article "Hardware Schedule" of this Section.

2.5 SCREWS, BOLTS, AND FASTENING DEVICES

- A. Where hardware groups/sets have different information refer to the following for clarification. Provide hardware groups/sets devices with detailed requirements for each type of device
- B. Fasteners
 1. General: Operable only by tools produced for use on specific type of fastener by fastener manufacturer or other licensed fabricator. Drive-system type, head style, material, and protective coating as required for assembly, installation, and strength, and as follows:
 2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Holo-Krome; a Danaher corporation.
 - b. Safety Socket LLC.
 - c. Tamper-Pruf Screws.
 - d. Textron Fastening Systems; Textron Inc.
 3. Fasteners not otherwise described herein must be security type in accordance with Section 11 98 16, requiring special tools to install and remove
 - a. Exposed Screws, Bolts, and Nuts: Meet ASTM A307 Grade A; in accordance with Section 11 98 16 and approved shop drawings.
 - b. Screw thread adhesive sealant: Provide and install with Loctite No. 271 A; in accordance with approved shop drawings.
 - c. Drive-System Types: Pinned Torx-Plus.
 - d. Fastener Strength: 120,000 psi (827 MPa).
 - e. Socket Button Head Fasteners:
 - 1) Heat-treated alloy steel, ASTM F835 (ASTM F835M).
 - 2) Stainless steel, ASTM F879 (ASTM F879M), Group 1 CW.
 - f. Socket Flat Countersunk Head Fasteners:
 - 1) Heat-treated alloy steel, ASTM F835 (ASTM F 35M).

- 2) Stainless steel, ASTM F879 (ASTM F879M), Group 1 CW.
- g. Socket Head Cap Fasteners:
 - 1) Heat-treated alloy steel, ASTM A574 (ASTM A574M).
 - 2) Stainless steel, ASTM F837 (ASTM F837M), Group 1 CW.
- h. Protective Coatings for Heat-Treated Alloy Steel:
 - 1) Zinc and clear trivalent chromium where indicated.
 - 2) Zinc phosphate with oil, ASTM F 1137, Grade I, or black oxide unless otherwise indicated.
- i. Finish exposed (exposed under any condition) screws to match hardware finish or, if exposed in surfaces of other work, to match finish of such other work as closely as possible, including "prepared for paint" in surfaces to receive painted finish.
- j. Threshold Anchors: Flat Sleeve Anchors (Pemko example FHSL 25 1/4 - 20 2 inch) cadmium plated expansion anchor screw in one unit.

2.6 SUBSTITUTIONS

- A. Products referenced by specific brand names and model numbers have been identified by Owner to match other products in use either completed or in the course of completion. No substitutions permitted per Public Contract Code Section 3400.
 - 1. Otherwise refer to Division 01 for substitutions.

2.7 COMBINE SPECIFICATIONS AND HARDWARE GROUPS/SETS IN SECTION 11 98 14, PART 3

- A. Where hardware groups/sets have different information, refer to the following for clarification. Provide hardware groups/sets devices along with added devices as indicated on drawings and detailed requirements for each type of device. Provide all products and services in specifications even if not written in hardware groups/sets in Part 3.

2.8 HANGING HARDWARE

- A. Butt Hinges:
 - 1. Where hardware groups/sets have different information (number of hinges and sizing), refer to the following for clarification. Provide hardware groups/sets devices along with added devices as indicated on Drawings and detailed requirements for each type of device.
 - a. Furnish and install Southern Steel - Cast Institutional Mortise Hinge as scheduled.
 - b. Furnish and install "weight/strength" as specified in hardware groups/sets in Part 3 (hinge nomenclature basis-of-design weight/strength).
 - c. Furnish and install two butts for doors up to 60 inches high and one additional butt for each 30 inches of height or fraction thereof. Furnish three butts for doors up to 36 inches wide. Furnish four butts for doors over 42 inches wide.

- d. Electric Hinges: Provide electrified hinges with certified UL Listed, concealed wires. Provide electric hinges with standardized wire colors to accommodate up to 12 wires (4, 6, 8 or 12 as required per to provide sufficient number of concealed wires to accommodate electric function of specified hardware). If additional wires are specified (more than needed for electrified devices), provide the wires specified.
- e. Products by the following manufacturers will be considered for acceptance providing all specified criteria have been met in full. Furnish all items and components of hardware required to complete the work in accordance with specifications, Contract Documents, and intended operation.
 - 1) Airteq.
 - 2) RR Brinks

2.9 SECURING DEVICES (LATCHING SYSTEMS)

- A. Where hardware groups/sets have different information, refer to the following for clarification. Provide hardware groups/sets devices along with added devices as indicated on Drawings and detailed requirements for each type of device
- B. Security Hardware Products:
 - 1. Locks:
 - a. Southern Steel.
 - 1) Basis of Design: Model as shown in schedule.
 - b. Airteq
 - c. RR Brinks
 - d. Or accepted equal
- C. Electro Bolt Lock for Swinging Doors:
 - 1. Appearance: System shall have a normal appearance when installed so that there are no cover boxes over the doors, no visible locking pilasters for mechanisms above or beside door jambs, and no special "lock pockets" or embedded items around door frames for housing mechanisms, keyed locks or releases. Door shall have lock knobs and hinges as specified, be contained in a normal-appearing mechanism and shall be concealed when door is closed.
 - 2. Electric Operation:
 - a. Under electric operation, it shall be possible to:
 - 1) Unlock the door by means of a push button switch located on the control panel. After being electrically unlocked, door shall automatically relock and deadlock when moved to the closed position.
 - b. In case of electrical failure, the lock shall fail in the locked position (secure).
 - c. Detail drawings of panel arrangement showing location of indicator lights, electric switches, manual release and other controls for each door are shown on Drawings and specified in Division 28.

- d. Electrical Requirements:
 - 1) Lock supplier to verify and/or coordinate electrical requirements.
 - 2) All electrical locks are to carry a UL label.
- 3. Contractor Responsibilities:
 - a. Detention Equipment Contractor shall provide and coordinate all doors, door frames, detention hardware, manual controls and factory-wired electrical units for each door and factory-wired door control panel, including relays, switches and indicator lamps. Detention Equipment Contractor shall also provide necessary raceways for manual controls from control panel to each swinging door operated therefrom.
 - b. Electrical Contractor shall furnish, install and connect to factory-wired terminal blocks all wiring from sources of supply to control panels and wires from control panels to electrical unit at each door. This shall include conduits and all other electrical units at each door, as well as conduits and other electrical equipment incident to power supply.
 - c. Electrical Requirements:
 - 1) Locks to require 24 VDC low voltage power.
 - 2) All electrical locks are to carry a UL label.
- 4. Contractor Responsibilities:
 - a. Detention Equipment Contractor shall provide and coordinate all doors, door frames, detention hardware, manual controls and factory-wired electrical units for each door and factory-wired door control panel, including relays, switches and indicator lamps. Detention Equipment Contractor shall also provide necessary raceways for manual controls from control panel to each swinging door operated therefrom.
 - b. Electrical Contractor shall furnish, install and connect to factory-wired molex connectors pigtailed all wiring from sources of supply to control panels and wires from control panels to electrical unit at each door. This shall include conduits and all other electrical units at each door, as well as conduits and other electrical equipment incidental to lock operation and monitoring of door position if required.

2.10 KEY SYSTEMS (CYLINDERS, CORES, AND KEYS.)

- A. Where hardware groups/sets have different information refer to the following for clarification. Provide hardware groups/sets devices along with added devices as indicated on drawings and detailed requirements for each type of device. Keying specifications below override hardware set/group nomenclature:
- B. Key Systems (Cylinders, Cores, and Keys):
 - 1. For all locking or dogging devices, provide complete keying system whether or not specified in Section 11 98 14, Part 3 hardware sets including lock cores, mortise cylinders, and rim cylinders keyed as directed by Owner in submittal process. Key System shall be:
 - a. ASSA Mogul Cylinders:

- b. Provide building standards – no substitutions.
 - 1) Manufacturer's standard pin-tumbler type, minimum 2-inch (50-mm) diameter; body constructed from brass or bronze, stainless steel, or nickel silver; with stainless-steel tumblers and engaging cylinder balls.
 - 2) Provide High-Security Grade: Listed and labeled as complying with pick- and drill-resistant testing requirements in UL 437 (Suffix A).
 - 3) Number of Pins: Six.
 - 4) Provide Mortise Type: Rim or Mortise type with blocking rings and quantity as required by locking device.
 - 5) Finish: BHMA 626. x appropriate cam.
 - 6) Size bow dimensions as manufactured by ASSA.
 - 7) Fabricate keys out of heat treated alloy bronze having a tensile strength of not less than 90,000 pounds and a hardness of the Brinnel scale of at least 170.
 - 8) Keyway: Provide as instructed by Owner during submittal process.

- C. Keying Requirements:
 - 1. Provide keyed, construction cylinders and keys during the construction period.
 - a. Provide brass construction cylinders and brass keys at all doors.
 - b. Plastic cores are not permitted.
 - c. Construction cylinders shall not be part of the Owner's permanent keying system or furnished in the same keyway or key section as the Owner's permanent keying system. Permanent cylinders and keys prepared according to the accepted keying schedule shall be furnished to the Owner.

 - 2. Keying Meeting and Programming Schedule:
 - a. After detention hardware, doors and frames has been submitted and reviewed in accordance with Division 01 requirements and Section 11 98 14, arrange a keying matrix/programming meeting with Owner and hardware supplier/Vendor representing the ASSA system. There shall be a minimum of two meetings and minimum of eight weeks prior to keying operations.
 - 1) Copies of the reviewed door and frame submittals shall be brought to the meeting with card reader and keyed doors highlighted for review.
 - 2) Follow procedures for keying meeting and programming schedule as outlined by the Door Hardware Institute. DHI procedures are based on example Door Hardware Institute core class entitled Masterkeying class #AHC200.

 - b. Keying meeting to produce a programming schedule/matrix based on the following:
 - 1) Furnish keys in the following quantities (total quantity of keys part of bid package):

- a) 5 each Grand master mogul keys per set.
 - b) 6 each Master mogul keys per set.
 - c) 10 each Change or Day mogul keys each lock, core or cylinder.
 - d) 20 each Construction master mogul keys during construction.
 - e) Stamp each key with number or letter as directed by Owner.
- 2) Provide keying system expansion parameters.
 - a) Plan twenty changes directly under the grand.
 - b) Plan ten master keys.
 - c) Plan fifty changes each for each master.
 - 3) Permanent keys and cores shall be stamped with the applicable key mark for identification. The visual key control marks or codes shall not include the actual key cuts.
 - 4) Permanent keys shall be stamped "Do Not Duplicate".
- c. Furnish meeting notes and three compete, typed copies of keying and programming schedule to Owner for final review. Submit editable / searchable electronic PDF copies of keying and programming schedule form via email electronic ftp site.
 - d. Furnish keying and programming schedule to Schlage manufacturing factory for production of cores, cylinders and other keyed devices.
3. Transmit cores/cylinders as well as grand masterkeys, masterkeys, change keys, and other security keys to Owner by Registered Mail, return receipt requested.
 4. Install permanent cores in presence of Owner.

2.11 CONCEALED CLOSERS

- A. LCN Model #2215DPS or as shown in schedule.
 1. Provide additional specification scope in above and below Section 11 98 14.
- B. Subject to conformance with requirements, alternative products or manufacturers are acceptable. Furnish all items and components of hardware required to complete the work in accordance with specifications, Contract Documents, and intended operation.
- C. Where hardware groups/sets have different information, refer to the following for clarification. Provide hardware groups/sets devices along with added devices as indicated on drawings and detailed requirements for each type of device:
 1. Grade 1; UL Listed; meets UL 10C and SFM Standard 12-7-4 for positive pressure fire test.
 2. Closers shall have multi-size spring power adjustment to permit setting of spring from 1 through 6 with additional spring power available. Provide ADA compliant setting nomenclature during submittals as recommended by closer manufacturer.

3. Submit correct closer type as to be able to install closers on non-public side of doors. Examples include, but are not limited to, 1) interior side of storage/electrical type rooms; 2) not in corridors/public areas 3) stair side of stairway doors; and at exterior locations, install closers inside of building (in conditioned spaces).
4. Installation Plates, Brackets, and Miscellaneous Adapters:
 - a. Provide drop plates, brackets, or adapters for arms as required to suit details and install as directed by manufacturer's templates.

2.12 STOPS AND HOLDERS

- A. Floor and Wall Door Stops/Holders and Bumpers:
 1. Acceptable Manufacturers:
 - a. Southern Steel 420 Door Stop.
 2. Products by the following manufacturers will be considered for acceptance providing all specified criteria have been met in full. Furnish all items and components of hardware required to complete the work in accordance with specifications, Contract Documents, and intended operation.
 - a. Airteq.
 - b. RR Brinks.
 3. Where hardware groups/sets have different information, refer to the following for clarification. Provide hardware groups/sets devices along with added devices as indicated on Drawings and detailed requirements for each type of device:
 - a. Coordinate with Section 05 40 00 and Section 09 22 16 for required wall backing.

2.13 ACCESSORIES

- A. Food pass/cuff ports.
 1. Acceptable Manufacturers:
 - a. By door and frame manufacturer and integral cuff port with door and continuous hinge.
 2. Products by the following manufacturers will be considered for acceptance providing all specified criteria have been met in full. Furnish all items and components of hardware required to complete the work in accordance with specifications, Contract Documents, and intended operation.
 - a. Southern /Folger (Southern Steel) #262 Food Pass.
 3. Where hardware groups/sets have different information, refer to the following for clarification. Provide hardware groups/sets devices along with added devices as indicated on Drawings and detailed requirements for each type of device:
 - a. The food pass opening shall be a flush opening fabricated using interior Zee-shaped formed sections 0.093 in. (2.3 mm) minimum thickness, securely welded to the inside of both face sheets. The four corner seams shall be continuously arc welded and dressed smooth. The finished opening shall be of such construction that it

cannot be dismantled or otherwise affected by tampering or scraping.

- b. The food pass shutter door shall be constructed from 0.067 inch (3.1 mm) thickness steel, press formed, hollow metal flush assembly with a 0.167 inch (4.2 mm) backup plate on the inmate side.
- c. The shutters shall be treated for maximum paint adhesion and given a shop coat of rust inhibitive primer. Shutters and food pass hardware shall be factory installed.

B. Pulls:

- 1. Raised Pull:
 - a. Southern Steel 212C.
- 2. Flush Pull:
 - a. Southern Steel 214S.
- 3. Products by the following manufacturers will be considered for acceptance providing all specified criteria have been met in full. Furnish all items and components of hardware required to complete the work in accordance with specifications, Contract Documents, and intended operation.
 - a. Airteq.
 - b. RR Brinks.

C. Kick/Mop Plates:

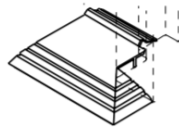
- 1. Acceptable Manufacturers:
 - a. Triangle Brass Manufacturing Company, Inc. (Trimco).
 - b. Rockwood.
 - c. Hager Manufacturing.
 - d. Ives Manufacturing.

D. Where hardware groups/sets have different information, refer to the following for clarification. Provide hardware groups/sets devices along with added devices as indicated on Drawings and detailed requirements for each type of device

- 1. Size at single doors:
 - a. Push side of door two inch less than door width. Hardware set/group nomenclature: 2 inches LDW.
 - b. Pull side and one inch less than door width. Hardware set/group nomenclature: 1-inch LDW.
- 2. At pairs of doors:
 - a. Width shall be one inch less than door width unless doors have protective edge guards or center mullions.
- 3. Height shall be 10 inches, unless otherwise indicated.
- 4. At all rated doors (UL smoke or fire), furnish protection plates with engraved UL listing information (example: Trimco added part #ULS added to all kickplates specified below that are on UL or rated doors/openings).

- E. Smoke Seals, Sound Seals, and/or Weatherstripping.
 - 1. Acceptable Manufacturers:
 - a. Pemko Manufacturing, Inc.
 - b. National Guard.
 - c. Zero International.
 - 2. Automatic door bottom with 1/2 inch to 1 inch drop; vinyl drop seal.
 - a. Factory installed where indicated.

- F. Astragals, Door Bottoms, and Thresholds:
 - 1. Acceptable Manufacturers:
 - a. Pemko Manufacturing, Inc.
 - b. National Guard Products (NGP).
 - c. Zero International.
 - d. Hager Manufacturing.
 - 2. Thresholds shall comply with CBC 2019 and shall not exceed 1/2 inch in height.
 - 3. Thresholds shall wrap frame stops (cut around stops, then continue into rabbits and face of frame).
 - a. Whether or not specified below, where thresholds are larger than frames all thresholds to have beveled miter ends.
 - b. 45-degree miter cut and a closed end, welded with returns to door/frame (example: NGP manufacturing nomenclature RCE throughout).



- G. Rubber Door Silencers:
 - 1. Provide rubber door silencer for each door opening in detention metal frame assemblies that are to be provided with a swing-type door.
 - 2. Three required for each opening where swing-type door is to be installed and four required for each opening where pair of swing-type doors are to be installed.

- H. Drip Guard:
 - 1. Provide at exterior doors exposed to rain per architectural details and flashing (or by door manufacturer to meet no water penetration warranties). For hollow metal doors, provide 346C x FFW full raindrips by Pemko or approved equal.
 - 2. Size: Full Frame Width (FFW).
 - 3. Provide devices painted to match adjacent frame. See Section 09 91 00 for paint and primer requirements.

2.14 POWER SUPPLIES, ELECTRIFIED HARDWARE, AND WIRES

- A. Door Position Switches:

1. Where hardware groups/sets have different information, refer to the following specifications for clarification and submit according to complete and intended electrified system per Contract Documents. See Architectural and Security drawings and specifications.
 - a. Door Position Switch/Closer (DPS): LCN 2215 DPS.
 - b. Coordinate door and frame preparations with door and frame suppliers.
- B. Power Supplies, Wires, and Relays:
 1. Where hardware groups/sets have different information (number of hinge wires and power supply information), refer to the following specifications for clarification and submit according to complete and intended electrified system per Contract Documents. See Architectural and Security drawings and specifications.
 - a. Coordinate use of power supplies with door and frame locations. Provide power supplies, relay, and battery backup units as part of the overall system in accordance with the manufacturer's warranty and system requirements. UL listed for applicable use; housed in an approved enclosure; and provide both Class 1 and Class 2 outputs.
 - b. Output shall be filtered and regulated. Relay, timer, and logic modules shall be provided as required for interface to indicated security components, and shall be assembled, connected and fully contained within the power supply enclosure.
 - c. Provide required connections to accommodate fire alarm/life safety system and/or security electronics for remote site monitoring of all electrified components and functions.

2.15 FABRICATION

- A. Factory assemble items where practicable, true to line and free of distortion or defects.
- B. Welding:
 1. Steel and stainless steel components not plant fabricated must be designed for field-welded connections.
 2. Plug or stitch welds unless otherwise indicated.
 3. Weld according to American Welding Society standards.
 4. Fill exposed joints with metallic filler, grind smooth.
 5. Remove burrs and rough edges.
- C. Equipment must be fully fabricated, assembled and finished, ready for final installation.
- D. Hardware:
 1. Hardware that is essentially non-projecting must be installed in doors and frames, at the factory, including the following:
 - a. Mechanical locks and their associated strikes, keepers and escutcheons.
 - b. Hinges, either screwed or welded, must be fastened to doors.

- c. Flush pulls.
- 2. Other hardware must be field installed; including closers, position indicators, pulls, cylinder shields, door hangers and guides, door bottoms and weather protection, projecting angle clips for cell door boots and gun ports in hollow metal frames.
- 3. The field installed hardware group for each opening must be separately packaged, accompanying the doors and clearly identified with its opening.

2.16 CLEANING AND FINISHING

- A. Galvanizing:
 - 1. Iron and Steel Hardware: ASTM A153.
 - 2. Shapes, Bars, Plates 1/8 inch or Greater Thickness: ASTM A123.
 - 3. Galvanized items must be G90 galvanized unless otherwise indicated.
 - 4. Galvanize exterior lock cases.
- B. Factory apply an additional coat of aluminum paint to unexposed surfaces of cover panels, cover boxes, control cabinets and door locking or operating parts.

2.17 EXTRA STOCK/SPARE PARTS

- A. Provide spare parts for each type of hardware listed in the hardware schedule as follows:
 - 1. Provide two each type 9724 x K2 x KCE x RLHB, 24 VDC - one right hand and one left hand.
- B. The Detention Equipment Contractor is responsible for making a full accounting of all hardware extra stock.

PART 3 - EXECUTION

3.1 INSTALLATION PREPARATION

- A. Inspection:
 - 1. Examine and inspect all surfaces, anchors and grounds that are to receive material, fixtures, assemblies and equipment specified herein. Report all unsatisfactory conditions.
 - 2. Check location, "roughing-in" and field dimensions prior to beginning work.
 - 3. Do not begin installation until all unsatisfactory conditions have been corrected.
 - 4. Proceeding with installation will be construed as evidence of acceptance of conditions under which work will be done.
- B. Protecting: Installer shall advise Contractor of required procedures for surveillance and protection of completed work. Advice shall extend through period of installation of other work near detention equipment work, and also through remainder of construction period for the purpose of ensuring that detention equipment will not be damaged.

3.2 INSTALLATION

- A. Comply with Section 11 98 00 requirements.
- B. Ship prepaid to door/frame manufacturer for factory installation the detention equipment hardware required for all types of detention equipment prison metal frame assemblies; deliver all other detention equipment hardware products to project site.

3.3 FIELD QUALITY CONTROL

- A. Detention equipment hardware manufacturer's representative is to inspect and approve work, in writing, after installation.

3.4 DETENTION DOOR HARDWARE SCHEDULE

- A. Manufacturers Legend:

<u>Code</u>	<u>Name</u>
SS	Southern Steel Manufacturing
AA	ASSA Cylinders
LC	LCN Closers
TR	Trimco Manufacturing
IV	Ives Manufacturing
PE	Pemko Manufacturing

- B. Hardware Columns - Example (Legend):

<u>Qty</u>	<u>Device Description</u>	<u>Device # (include specification language)</u>	<u>Finish</u>	<u>Manu</u>
1	-----	-----	--	--

- C. The following hardware sets are intended to establish type and standard of quality when used together with the requirements of this Section. See above Section and related Sections including Division 01.
 - 1. Examine Contract Documents and furnish proper hardware for door openings.
 - 2. Refer to Door Schedule on the Drawings for Hardware Group/Set assignments for each opening.

Hardware Group/Set #DH1

4	Ea.	Hinges	204FMSS x security torx fasteners	630	SS
1	Ea.	In-Frame Double Keyed, Fire-Rated Electrified Locking / Latching Device	10120AM x K2, 24 VDC Power	630	SS
2	Ea.	Mogul Cylinder	Per Section 11 98 14		
2	Ea.	Raised Pull	212C	630	SS
1	Ea.	Closer x Door Position Switch	LCN 2215DPS x security torx fasteners per specifications. Coordinate door and frame preparation/templates and Divisions 25-28 with Security applicable drawings	689	LC
2	Ea.	Kick Plate	KO050 16" tall x 2" LDW (less door width) x B4E (beveled edges) x counter sunk where door allows	630	TR
1	Ea.	Door Stop	420		SS
1	Ea.	Seal (weatherstripping)	S88D with Perforation Feature (head and jambs)		PE
1	Ea.	Door Bottom Sweep	210APK x security torx fasteners per specifications		PE
1	Ea.	Threshold	2727A or 176A or per detail (sized to fit the condition) x security torx fasteners		PE
1	Ea.	Overhead Rain Drip (where occurs)	Per architectural details and flashing at uncovered areas (or by door manufacturer to meet no water penetration warranties – verify before submittals). For hollow metal doors, provide 346C x FFW full raindrips by Pemko or approved equal.		
1	Ea.	Coordination task for security and/or electrical design and additional non-Division 08 Section scope (including but not limited to wire / connectivity from ground or ceiling through frame to electrified hardware)	By security or electrical as required per Contract Documents: - Coordinate with security or electrical Divisions 25-28 and applicable drawings.		
1	Ea.	Power Supply	Coordinate with security Divisions 28 and applicable drawings as hardware does not include.		

NOTE: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents including, but not limited to, additional hardware devices requirements in the above specification language, architectural plans, and full specification documents.

Hardware Group/Set #DH2

4	Ea.	Hinges	204FMSS x security torx fasteners	630	SS
1	Ea.	In-Frame Double Keyed, Fire-Rated Electrified Locking / Latching Device	10120AM x K2, 24 VDC Power	630	SS
2	Ea.	Cylinder	Per Section 11 98 14		
2	Ea.	Raised Pull	212C	630	SS
1	Ea.	Closer x Door Position Switch	LCN 2215DPS x security torx fasteners per specifications. Coordinate door and frame preparation/templates and Divisions 25-28 with Security applicable drawings	689	LC
2	Ea.	Kick Plate	KO050 16" tall x 2" LDW (less door width) x B4E (beveled edges) x counter sunk where door allows	630	TR
1	Ea.	Door Stop	420		SS
1	Ea.	Seal (rated)	S88D with Perforation Feature (head and jambs)		PE
1	Ea.	Coordination task for	By security or electrical as required per Contract Documents:		

		security and/or electrical design and additional non-Division 11 Section scope (including but not limited to wire / connectivity from ground or ceiling through frame to electrified hardware)	- Coordinate with security or electrical Divisions 25-28 and applicable drawings.
1	Ea.	Power Supply	Coordinate with security Divisions 28 and applicable drawings as hardware does not include.
NOTE: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents including, but not limited to, additional hardware devices requirements in the above specification language, architectural plans, and full specification documents.			

Hardware Group/Set #DH3

4	Ea.	Hinges	204FMSS x security torx fasteners	630	SS
1	Ea.	In-Frame Double Keyed, Fire-Rated Electrified Locking / Latching Device	10120AM x K2, 24 VDC Power (do not prep push-side of door with cylinder hole, cylinder on to be on exterior side for emergency entry)	630	SS
2	Ea.	Cylinder	Per Section 11 98 14		
1	Ea.	Raised Pull	212C	630	SS
1	Ea.	Flush Pull	214S	630	SS
1	Ea.	Closer x Door Position Switch	LCN 2215DPS x security torx fasteners per specifications. Coordinate door and frame preparation/templates and Divisions 25-28 with Security applicable drawings	689	LC
2	Ea.	Kick Plate	KO050 16" tall x 2" LDW (less door width) x B4E (beveled edges) x counter sunk where door allows	630	TR
1	Ea.	Door Stop	420		SS
1	Ea.	Seal (weatherstripping)	S88D with Perforation Feature (head and jambs)		PE
1	Ea.	Coordination task for security and/or electrical design and additional non-Division 08 Section scope (including but not limited to wire / connectivity from ground or ceiling through frame to electrified hardware)	By security or electrical as required per Contract Documents: - Coordinate with security or electrical Divisions 25-28 and applicable drawings.		
1	Ea.	Power Supply	Coordinate with security Divisions 28 and applicable drawings as hardware does not include.		
NOTE: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents including, but not limited to, additional hardware devices requirements in the above specification language, architectural plans, and full specification documents.					

Hardware Group/Set #DH4

1	Ea.	Cuff Port with Continuous Hinge	By door and frame manufacturer and integral cuff port with door and continuous hinge		
1	Ea.	Food pass lock	1017AM Snaplatch (coordinate with door manufacturer and integral cuff port)	630	SS
3	Ea.	Hinges	204FMSS x security torx fasteners	630	SS
1	Ea.	In-Frame Single Keyed, Electrified Locking / Latching Device	10120AM x K1, 24 VDC Power	630	SS
1	Ea.	Cylinder	Per Section 11 98 14		
1	Ea.	Raised Pull	212C	630	SS
1	Ea.	Flush Pull (interior side)	214S	630	SS
1	Ea.	Kick Plate	KO050 16" tall x 2" LDW (less door width) x B4E (beveled edges) x counter sunk where door allows	630	TR
1	Ea.	Door Stop	420		SS
1	Ea.	Door Position Switch (also known as Alarm Contact)	200MRS x security torx fasteners. Coordinate door and frame preparation/templates for DPS devices and with Security Divisions 25-28 and applicable drawings		SS
1	Ea.	Coordination task for security and/or electrical design and additional non-Division 08 Section scope (including but not limited to wire / connectivity from ground or ceiling through frame to electrified hardware)	By security or electrical as required per Contract Documents: - Coordinate with security or electrical Divisions 25-28 and applicable drawings.		
1	Ea.	Power Supply	Coordinate with security Divisions 28 and applicable drawings as hardware does not include.		

NOTE: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents including, but not limited to, additional hardware devices requirements in the above specification language, architectural plans, and full specification documents.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Security glazing for detention hollow metal doors, windows, and frames.
- B. Glazing accessories.

1.2 REFERENCES

- A. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- B. Referenced Standards:
 - 1. AAMA 800 – Voluntary Specifications and Test Methods for Sealants.
 - 2. ASTM C920 – Standard Specification for Elastomeric Joint Sealants.
 - 3. ASTM C1036 – Standard Specification for Flat Glass.
 - 4. ASTM C1048 – Standard Specification for Heat-Treated Flat Glass – Kind HS, Kind FT Coated and Uncoated Glass.
 - 5. ASTM C1349 – Standard Specification for Architectural Flat Glass Clad Polycarbonate.
 - 6. ASTM D256 – Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics.
 - 7. ASTM D790 – Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
 - 8. ASTM D1003 – Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics.
 - 9. ASTM E119 – Standard Test Methods for Fire Tests of Building Construction and Materials.
 - 10. ASTM F1915 – Standard Test Methods for Glazing for Detention Facilities.
 - 11. GANA – Glazing Manual, latest edition.
 - 12. UL 263 – Standard for Fire Tests of Building Construction and Materials.
 - 13. UL 752 – Standard for Bullet-Resisting Equipment.
 - 14. WMFL – Walker, McGough, Foltz, and Lyerla 8801 Attack Resistant Standard.

1.3 SUBMITTALS

- A. Submit data on glazing types specified: Provide structural, physical and environmental test characteristics, size limitations, special handling or installation requirements.
- B. Product data on glazing sealants, glazing tapes, and setting blocks: Provide functional and environmental characteristics, limitations, and special application requirements. Identify available colors.

- C. Samples: Submit two samples, 12 inches x 12 inches in size, illustrating each type of security glazing, clearly marked, in actual assembly for each type.
- D. Provide a detailed drawings of intended installation including setting blocks, sealants, and glazing tape along with certification of compatibility with glazing units from the security glazing manufacturer.

1.4 QUALITY ASSURANCE

- A. Perform work in accordance with GANA Glazing Manual and Installer's Qualifications: The installation shall be performed only by an installation firm with a minimum of five years' experience in this business. All work shall be performed by qualified mechanics that specialize in security glazing installation.
- B. Manufacturer's experience: Manufacturer shall have a minimum of five years' experience, with documented installation of identical product to that specified.

1.5 PERFORMANCE REQUIREMENTS

- A. Provide WMFL and ASTM F1915 Test Reports certified by independent testing laboratory for each type of security glazing products specified.

1.6 FIELD MEASUREMENTS

- A. Verify that field measurements are as indicated on shop drawings.

1.7 COORDINATION

- A. Coordinate the work with glazing frames, wall openings, and adjacent work.
- B. Conduct coordination meeting with at least two weeks prior to the start of work of this Section. Meeting attendees shall include Contractor, installer, glazing manufacturer, painters, and all other relevant trades to review needs concerns impact of other trades on installation of security glazing.

1.8 DELIVERY, STORAGE AND HANDLING

- A. Deliver glazing with manufacturer's labels intact and store in protected areas. Keep glazing free from contamination by materials capable of staining glazing.
- B. Deliver glazing sealants, tapes, accessories, and specialty items in manufacturer's unopened, labeled packaging.
- C. Handling: Glazing shall be carefully handled and glazed to avoid damage.

1.9 EXTRA STOCK

- A. Extra Stock/Spare Parts: Furnish a stock equaling three percent of the quantity required on the project for each product, but not less than one unit of each product, of each size. Provide protection for transit and storage.
- B. Size of all attic stock panels shall be determined by Architect.
- C. Package, mark for identification, and deliver to Owner's designated storage space as directed.

1.10 WARRANTY

- A. Provide five-year warranty against delamination of glass clad polycarbonate security glazing.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers:
 - 1. McGrory Glass Inc.
 - 2. SaftiFirst (A Division of O’Keeffe’s Inc.)
 - 3. Global Security Glazing ("Secur-Tem+Poly" Glass Clad Polycarbonate)
 - 4. Oldcastle Building Envelope ("ArmorProtect" Glass Clad Polycarbonate)
 - 5. The LTI Group ("Smartgard" Glass Clad Polycarbonate)
 - 6. Or accepted equal.

2.2 SECURITY GLAZING TYPES

- A. TYPE SG-1: Insulated glass unit, 1-3/4 inches thick nominal, clear glass clad polycarbonate, ASTM F1915 Security Grade 1 (60 minute) rated with 1/2-inch air space and 1/4 inch heat strengthened clear glass outboard with SB-70 Low-E coating on #2 surface.
 - 1. Basis-of-Design Product: McGrory Glass AttackDefend 60 Insulated to Clear SB-70 HS #2.
- B. TYPE SG-2: Insulated glass unit, 1-3/4 inches thick nominal, clear glass clad polycarbonate with white urethane interlayer, ASTM F1915 Security Grade 1 (60 minute) rated with 1/2-inch air space and 1/4 inch heat strengthened clear glass outboard with SB-70 Low-E coating on #2 surface.
 - 1. Basis-of-Design Product: McGrory Glass AttackDefend 60WU Insulated to Clear SB-70 HS #2.
- C. TYPE SG-3: 13/16 inch thick nominal, clear glass clad polycarbonate, ASTM F1915 Security Grade 2 (40 minute) rated.
 - 1. Basis-of-Design Product: McGrory Glass AttackDefend 40
- D. TYPE SG-4: Thickness per manufacturer to obtain fire and attack ratings required, clear non-wired glass, ASTM E119 & UL-263 45-minute fire rated, ASTM F1915 & CDCR 860-14a Security Grade 2 (40 minute) rated.
 - 1. Basis-of-Design Product: SaftiFirst SuperSecure II-XLS 45.
- E. TYPE SG-5: 9/16 inch thick nominal, clear glass clad polycarbonate, ASTM F1915 Security Grade 4 (10 minute) rated.
 - 1. Basis-of-Design Product: McGrory Glass AttackDefend 10

2.3 GLAZING COMPONENTS

- A. Following materials are required as components for units except material requirements are general; provide specific materials as recommended by manufacturer (laminator) of units, to comply with ASTM C1349, specified minimum performance criteria, and additional requirements.

1. Glass Sheets: Type I, quality Q3 glass in conformance with ASTM C1036 and ASTM C1048. Outer layer of all units shall be clear heat or chemically strengthened glass; thicknesses as indicated above.
2. Polycarbonate Sheets: Clear, transparent, cast polycarbonate sheet with additional characteristics and performances as recommended by manufacturer (laminator) of units; with flexural strength of not less than 13,500 psi per ASTM D790; 240 degrees F allowable continuous service temperature; 95 percent light transmittance for 1/4 inch thick sheet per ASTM D1003; Izod strength of 16 foot-pounds per inch minimum per ASTM D256.
3. Interlayer: Clear, transparent, high-impact-resistant permanent urethane film of a composition which has successfully withstood a minimum of twenty years of exposure to sunlight and severe weather/temperature changes as required for specified "arms" rating and overall thickness lamination.

2.4 GLAZING SEALANTS

- A. Material: Silicone sealants in conformance with ASTM C920.
- B. Acceptable Manufacturers and Products:
 1. Exterior Surfaces:
 - a. Tremco, Product: Spectrem 2.
 - b. GE, Product: 2200.
 - c. Or accepted equal.
 2. Interior Surfaces – Glazing to Hollow Metal Frame:
 - a. Pecora, Product: Dynaflex SC Security Sealant.
 - 1) Do not use this product in contact with polycarbonate.
 - b. Or accepted equal.

2.5 GLAZING TAPE

- A. Material: 100 percent solids butyl tapes in conformance with AAMA 800.
- B. Acceptable Manufacturers and Products:
 1. Tremco, Product: 440.
 2. Parr Technologies, LLC, Product: PTI 303.
 3. Or accepted equal

2.6 GLAZING ACCESSORIES

- A. Setting Blocks: Provide type recommended, subject to compatibility testing and approval by security glazing manufacturer.
 1. Santoprene (silicone).
 2. Thermoplastic rubber (TPR).
- B. Miscellaneous: Furnish all primers, sealers, blocks, shims, spacers, seals etc. as required for a complete installation.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify prepared openings for adequacy to receive glazing.
- B. Verify openings for glazing are correctly sized and within tolerance.
- C. Verify that surfaces of glazing channels or recesses are clean, free of obstructions, and ready to receive glazing.

3.2 PREPARATION

- A. Clean contact surfaces with solvent and wipe dry.
- B. Apply primer or sealer to joint surfaces wherever recommended by sealant manufacturer.
- C. Check that glazing is free of edge damage and surface defects.

3.3 INSTALLATION

- A. Install security glazing and accessories in accordance with glazing manufacturer's recommendations.
- B. Protect glazing from edge damage at all times during handling, installation, and subsequent operation of the glazed components of the work.
- C. Glazing channel dimensions are intended to provide for necessary bite on the glazing, minimum edge clearance and adequate sealant thicknesses, with reasonable tolerances. The glazier is responsible for correct glazing size for each opening, within the tolerances and necessary dimensions established and for verifying the dimensions of the glazing stops.
- D. At all interior detention doors and frames scheduled to receive security glazing, apply pick-proof sealant and set flush with edge of stop. Protruding sealant not installed in a neat, flush, professional manner shall be completely removed and replaced at no cost to Owner. Do not allow security sealant to come in to contact with polycarbonate surfaces.

3.4 CURE AND PROTECTION

- A. Cure glazing sealants, in compliance with manufacturer's instructions and recommendations, to obtain high early bond strength, internal cohesive strength and surface durability.
- B. Protect glazing sealants and compounds during the construction period, so that they will be without deterioration or damage (other than normal weathering) at the time of Project Completion.
- C. Remove and replace glazing that is broken, chipped, cracked, abraded or damaged during the construction period.
- D. Leave entire work in neat, orderly, clean condition at time of Project Completion.

3.5 CLEANING GLAZING

- A. Clean glazing under provisions of Division 01 and per glazing manufacturer's recommendations.
- B. Maintain glazing in a clean condition during construction so that it will not be damaged by corrosive action and will not contribute (by wash-off) to the deterioration of glazing materials and other work. Use only glazing manufacturer approved cleaning solutions.
- C. It shall be the responsibility of the Contractor to provide the Owner with the security glazing manufacturer's proper cleaning instructions, assuring that only compatible cleaning products are to be used. Failure to do so may void the glazing warranty.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Dayroom tables and seats.
- B. Dorm bunks.
- C. Wall mounted mirrors.
- D. Recessed shelves.
- E. Towel hooks.
- F. Ligature-resistant grab bars.
- G. Floor mount stools.
- H. Wall mount swivel stools.
- I. Wall hung desk.
- J. Video visitation cabinets.
- K. Telephone pedestal.
- L. Pistol lockers.
- M. Key cabinet.
- N. Soap dispensers.
- O. Paper towel dispensers.
- P. Toilet paper roll holders.

1.2 RELATED SECTIONS

1.3 SUBMITTALS

- A. Shop Drawings
 - 1. Indicate fabrication, materials, installation details, finishes, and required anchoring, fasteners, and hardware for each product specified in this Section.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Store in manufacturer's original unopened containers and packaging. Protect from damage. Handle products to prevent damage to products or finishes.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Norix Group
- B. Chief Industries, Inc.
- C. Sweeper Metal Fabrications
- D. Or accepted equal

2.2 DAYROOM TABLES AND SEATS

- A. Basis of Design: Norix Group, Inc. Max-Master Table Model No. MX5400-6-GT, (six-seat round) dayroom tables and seats with game tops.
 - 1. Table Tops:
 - a. Six Seat Table Top: 54 inches diameter, 45 pound density particle board with permanently embedded T-nuts for securing top to base. Finish shall be Wilsonart Titanium Evolve #4810-60 high pressure plastic laminate with black Slammer Stone radiused edges and Nu-Stone checkerboard inlay game top.
 - 2. Seats: 12 inches diameter, one piece, 14 gauge Type 304 stainless steel with #4 brushed finish. Provide 1-1/2 inch drop edge and stainless steel mounting studs.
 - 3. Base: 3 inch diameter, 14 gauge steel tubing with 6 inch x 6 inch x 1/4 inch thick steel mounting plates for top and seats. Provide powder coat paint finish.
 - 4. Installation: Tamper-resistant bolt-down system.
- B. Basis of Design: Norix Group, Inc. Max-Master Table Model No. M44200-4-GT, (four-seat round) dayroom tables and seats with game tops.
 - 1. Table Tops:
 - a. Four Seat Table Game Top: 42 inches diameter, 45 pound density particle board with permanently embedded T-nuts for securing top to base. Finish shall be Wilsonart Titanium Evolve #4810-60 high pressure plastic laminate with black Slammer Stone radiused edges and Nu-Stone checkerboard inlay game top. Top Height: 31.75 inches.
 - 2. Seats: 12 inches diameter, one piece, 14 gauge Type 304 stainless steel with #4 brushed finish. Provide 1-1/2 inch drop edge and stainless steel mounting studs. Seat height: 19.75 inches.
 - 3. Legs: 3 inch diameter, 14 gauge, curved tubular steel with 10 inch radius bend to support the top. The curved shall be fully welded to a vertical steel tube that supports the seat. The top of the curved tubes and top of the seat tubes shall have fully welded 6 inch x 6 inch x 1/4 inch thick steel mounting plates for top and seats. Bottom of seat tube shall have a fully welded mounting plate inset. The inset shall have a hole for the fully enclosed, tamper-resistant, bolt-down system. Provide black powder coat paint finish.
- C. ADA Compliance: One table unit within each housing unit shall omit one seat to accommodate a disabled inmate.

2.3 DORM BUNKS

- A. Basis of Design: Floor Mounted Welded Double Bunks: Norix Group, Inc. Model No. B510-223, custom size of minimum clear 76 inches long x minimum clear 30 inches wide x 52 inches high with factory-applied polyester powder coat paint finish, color as selected by Architect.
 - 1. Bed Tray: 10 gauge steel.
 - 2. Legs: 2 inch x 2 inch x 3/16 inch steel angle legs with bolt-down floor tabs. Single leg shall be 16 inches high and double leg shall be 52 inches high.
 - 3. Accessories:
 - a. Norix Group, Inc. Model No. PB300 Property Box with under bunk rails.

- 1) Size: 12.5 inches high x 22.875 inches wide x 17.875 inches deep.
- 2) Material: Injection molded from structural polyethylene.
- b. Norix Group, Inc. Model No. PBL400 Property Box Lid.
 - 1) Size: 1 inch high x 23.125 inches wide x 18 inches deep.
 - 2) Material: Injection molded from structural polyethylene.
- c. Provide two sets of each for each double bunk.

2.4 WALL MOUNTED MIRRORS

- A. Basis of Design: Norix Group, Inc. Model No. R565-411, wall mounted stainless steel mirror.
 1. Overall size: 17-1/4 inches high x 11-1/4 inches wide.
 2. Materials: One-piece stamped 18 gauge Type 430 stainless steel with #8 finish; mirror surface highly polished.
 3. Provide countersunk holes for tamper resistant stainless steel fasteners.

2.5 RECESSED SHELVES

- A. Basis of Design: Norix Group, Inc. Model No. S565-550 stainless steel recessed shelf.
 1. Overall Size: 7-1/2 inches high x 18 inches wide x 4 inches deep.
 2. Opening Size: 5 inches high x 16 inches wide x 4 inches deep.
 3. Materials: Formed and welded 16 gauge Type 304 stainless steel.
 4. Finishes: #4 finish on exposed surfaces; brushed stainless steel frame; satin interior.
 5. Provide welded anchor nuts at back of shelf to receive threaded studs.
- B. Basis of Design: Acorn Engineering Company, Model No. 1820 stainless steel recessed shelf.
 1. Overall Size: 7 inches high x 18 inches wide. Depth for wall thickness up to 4-1/4 inches.
 2. Opening Size: 5 inches high by 16 inches wide.
 3. Materials: Type 304 stainless steel with #4 satin finish.
 4. Provide welded anchor nuts at back of shelf to receive threaded studs.

2.6 TOWEL HOOKS

- A. Basis of Design: Norix Group, Inc. Model No. ITS-410 4 Strip Front Mount Towel Hook with four ball style, jam resistant collapsible hooks.
 1. Size: 5-1/2 inches high x 18 inches wide x 1.313 inches deep.
 2. Backplate: One-piece formed and ground smooth 14 gauge Type 304 stainless steel with brushed finish.
 3. Safety Hooks: Cast and machined Type 304 stainless steel with brushed finish and stainless steel ball and spring.
- B. Basis of Design: Norix Group, Inc. Model No. S565-529 4 Strip Front Mount Towel Hook with shelf with four ball style, jam resistant collapsible hooks.
 1. Size: 11 inches high x 18 inches wide x 1.313 inches deep.
 2. Backplate: One-piece formed and ground smooth 14 gauge Type 304 stainless steel with brushed finish.
 3. Safety Hooks: Cast and machined Type 304 stainless steel with brushed finish and stainless steel ball and spring.

2.7 LIGATURE-RESISTANT GRAB BARS

- A. Basis of Design: Willoughby Industries, Model No. ASGB48 grab bars, 48 inches long, Model No. ASGB42 grab bars, 42 inches long, Model No. ASGB36 grab bars, 36 inches long, Model No. ASGB30 grab bars, 30 inches long and ASGB24 grab bars, 24 inches long.
 1. Flanges: 11 gauge, 3 inch diameter, Type 304 (18-8) stainless steel with #3 satin finish.

2. Tubing: 18 gauge, 1-1/2 inch outside diameter, seamless Type 304 (18-8) stainless steel with #3 satin finish. Bent ends of tubing pass through the flanges and shall be heliarc welded into a single structural unit for maximum strength. Intermediate supports shall be contour cut and joined by heliarc welding to form an integral part of the grab bar. All welds shall be ground and polished to blend. Fabricate using mandrel bending process to maintain uniform bar diameter. Returns shall provide 1-1/2 inch minimum clearance between wall and bar.
3. Closure Plate: 11 gauge, Type 304 (18-8) stainless steel with #3 satin finish, heliarc welded to edge between tube and wall.
4. Fasteners: Stainless steel, torx-head mounting screws.

2.8 FLOOR MOUNT STOOLS

- A. Basis of Design: Norix Group, Inc. Model No. S561-147, 12 inches diameter, 14 gauge Type 304 stainless steel seat with #4 finish and 18 inch high, 14 gauge, 2-1/2 inch diameter steel tube post welded to 6 inch x 6 inch x 1/4 inch steel plates. Steel components shall receive baked-on epoxy powder coat paint finish.

2.9 WALL MOUNT SWIVEL STOOLS

- A. Basis of Design: Norix Group, Inc. Model No. D564-111 wall mount swivel seat with 1/8 inch thick wall steel tube welded to 6 inch x 6 inch x 1/4 inch thick steel wall mounting plate. Seat shall be 12 inches diameter, 14 gauge Type 304 stainless steel seat with #4 finish. Steel components shall have a powder coat paint finish.

2.10 WALL HUNG DESK

- A. Basis of Design: Norix Group, Inc. Model No. DS560-401 Wall hung fully enclosed, tamper-resistant cell desk.
 1. Overall Size: 20 inches wide x 16 inches deep x 10 inches high at wall.
 2. Material: 16 gauge, type 304 stainless steel, #4 finish.
 3. Interior of desk shall be filled with fiberglass insulation for sound deadening.

2.11 VIDEO VISITATION CABINETS

- A. Basis of Design: Norix Group Inc., IntelStation Model No. SBF7S wall mounted open style stainless steel cabinets with seat. Provide Model No. SBF9S add-on units.
 1. Materials:
 - a. Surface Mount Panel, Divider Panels, and Writing Surface: 12 gauge stainless steel with #4 finish. Writing surface, divider panels, cabinet top, and face plate shall be securely connected with tamper-resistant fasteners.
 - b. Seats: 12 inch diameter, one piece, 14 gauge Type 304 stainless steel with #4 satin finish and 1-1/2 inch drop edge.
 - c. Legs and Seat Support: 10 inch radius curved portion of the leg supports the top and shall be fully welded to the vertical tube that supports the seat. The top of the curved tube and top of the seat support tube shall be fully welded to 6 inch x 6 inch x 1/4 inch thick steel plate. The bottom of the seat tube shall be fully enclosed to conceal floor mounting anchors. Support tubes shall be 14 gauge, 3 inch diameter steel, fully welded, with black powder coat paint finish.
- B. Basis of Design: Norix Group Inc., IntelStation Model No. SBF9N accessible wall mounted open style stainless steel cabinets without seat.
 1. Materials:
 - a. Surface Mount Panel, Divider Panels, and Writing Surface: 12 gauge stainless steel with #4 finish. Writing surface, divider panels, cabinet top, and face plate shall

- be securely connected with tamper-resistant fasteners.
- b. Wall Mount Brackets: 1/4 inch thick steel with powder coat paint finish.
- c. Wall Hanger: 10 gauge steel with powder coat paint finish.

2.12 TELEPHONE PEDESTAL

- A. Basis of Design: Telecom Products, Inc., Inmate Pedestal, or accepted equal, for attachment of inmate telephone.
 - 1. Size: 10 inches wide by 10 inches deep by 55.5 inches height.
 - 2. Material: 1/8-inch solid steel construction.
 - 3. No entry points for inmates.
 - 4. Finish: Black powdercoat.

2.13 PISTOL LOCKERS

- A. Basis of Design: Norix Group, Inc. Model No. IPL-600 surface mounted six compartment steel pistol lockers.
 - 1. Overall Size: 33-1/2 inches high x 39 inches wide x 5 inches deep.
 - 2. Materials:
 - a. 7 gauge steel at drawer fronts and body front and sides; cut, formed, welded, and ground smooth.
 - b. 10 gauge steel at body back and drawer sides and backs; cut, formed, welded, and ground smooth.
 - c. Mounting Flange: 2 inches x 2 inches x 3/16 inch steel.
 - d. Hinges: 14 gauge steel.
 - e. Provide 1/8 inch thick felt lining in drawers.
 - 3. Locks: One pin tumbler snap lock at each drawer, individually keyed and master keyed.
 - a. Provide two keys per compartment and two master keys per locker.

2.14 KEY CABINET

- A. Basis of Design: Norix Group, Inc. Model No. IKC-300 surface mounted locking key cabinet to accommodate 300 paracentric and mogul keys.
 - 1. Material: Cut, formed, and welded 10 gauge steel.
 - 2. Dimensions: 24 inches high by 16-5/8 inches wide x 7 inches deep.
 - 3. Hardware:
 - a. Hinges: Continuous door hinge with two hinged inside panels.
 - b. Locking: Institutional lever tumbler dead bolt with one key.
 - 4. Finish: Factory primed.

2.15 SOAP DISPENSERS

- A. Basis of Design: Archer Manufacturing Model No. 1015-01G OPS Vandal Proof Soap Dispenser.
 - 1. Size: 10-1/8 inch high x 5-1/2 inches wide x 4-3/8 inches deep.
 - 2. Fabrication: Stainless steel dispenser with circular keyway cam lock.
 - 3. ADA compliant and ligation resistant.

2.16 PAPER TOWEL DISPENSERS

- A. Basis of Design: Archer Manufacturing Model No. 1100-01G OPS Vandal Proof High Capacity Paper Towel Dispenser.
 - 1. Size: 17 inches high x 9.2 inches wide x 4 inches deep.
 - 2. Fabrication: Stainless steel dispenser with circular keyway cam lock.
 - 3. ADA compliant and ligation resistant.

4. Capacity: 1500 sheets.

2.17 TOILET PAPER ROLL HOLDERS

- A. KG13 Anit-Ligature Recessed: Kingsway Group USA
 1. Material: Type 316 Stainless Steel.
 2. Dimensions: 7 inch by 8 inch and 3.875 inch depth.

PART 3 EXECUTION

3.1 INSTALLATION

- A. All products and materials specified in this Section shall be installed according to manufacturer's instructions and as detailed on the Drawings.

3.2 ADJUST AND CLEAN

- A. Clean and Touch-up: Remove all packing and protection blemishes and thoroughly clean and polish all finish surfaces. Restore any marred or abraded surfaces to their original condition by touching up in accordance with the manufacturer's recommendations. Touch-up shall not be obvious.
- B. Defective work: Remove and replace all defective work which cannot be properly repaired, cleaned or touched up, as directed by Architect, with no additional cost.
- C. Protect installed work during the construction period to prevent abuse and damage.

END OF SECTION

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Manually operated horizontal louver blinds complete with controls.

1.02 SUBMITTAL ITEMS

- A. Shop Drawings: Submit showing each typical blind installation, fully detailing attachments.
- B. Samples: Submit Samples showing acceptable match with specified colors; when approved submit one mock-up blind of each type operation, about 4-feet high by 3-feet wide complete with paint finish of approved color and hardware for approval.
- C. Product Data: Submit manufacturer's catalog data.

1.03 JOB CONDITIONS

- A. Take accurate measurements at site prior to fabrication of blinds. Coordinate installation with acoustical ceiling trade.

1.04 WARRANTY

- A. In addition to the standard 1-year warranty, furnish to Owner a Limited Lifetime Warranty.

PART 2 - PRODUCTS

2.01 MANUALLY OPERATED BLINDS

- A. Provide Rivera blinds as manufactured by Levelor, or equal, 1" wide slat type with "invisible" type ladders, all steel parts treated at the factory with a corrosion resistant plating or treatment.
- B. Blind Materials:
 - 1. Slats: Color coordinated 1 inch metal, 8 gauge. Finish with manufacturer's standard colors selected by architect from manufacturer's available contract colors.
 - 2. Headrail: Heavy-duty, high-profile steel measuring 2 inches x 1 ¼ inches with U-shaped rolled edges treated with iron phosphate to resist corrosion. Internally fit with components required for specific performance and designed for smooth, quite trouble-free operation. Headrail finish to be standard baked-on polyester and to coordinate with slats. .
 - 3. Bottomrail: Color coordinated hollow trapezoid bottomrail with recessed end-caps, 50mm width x 15mm height – passes 500 hour UV rated & NFPA 701 Fire retardant test. Engineered polymer tape buttons secure the ladder and cord. Finish to be manufacturer's standard colors or stained finish to match slats.
 - 4. Lifting Mechanism: Engineered polymer and galvanized steel housing cord-locks with polymer roller bearing and steel locking pin. Two-ply polyester cord filler in braided polyester jacket lift cords meet or exceed commercial specification

1029.86. Cord connectors are ANSI Standard color coordinated breakaway safety devices passing ANSI/WCMA A100.1-2018.

5. Tilt Mechanism: Permanently lubricated die-cast worm and gear type tilter. Gear mechanism in fully enclosed housing with clutch action to prevent ladder tapes from over-rotation.
6. Tilt Control Wand: Rounded 3/8 inch diameter, constructed by PVC, color coordinated to match slats and detachable without tools. Located on either side of individual blind unit per architect's request.
7. Mounting Hardware: Standard hinged cover end support brackets of electroplated steel with finish coat of baked on polyester enamel in color to match headrail. Intermediate support brackets for blinds over 60 inches wide.
8. Valance: 3 inch color coordinated contoured valance. PVC – passes 500 hour UV rated & NFPA 701 fire retardant test.

C. Finish: Color to be selected by Architect from manufacturer's full range of colors.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Report to Architect in writing those conditions that prevent or interface with correct installation of Work of this Section.

3.02 INSTALLATION

- A. Conform to blind manufacturer's instructions and approved submittals. Examine each blind for damage or defects prior to installation. Do not install any scratched, bent or otherwise defective blinds. Test each component for proper functioning under all conditions of operation. Demonstrate that each blind operates correctly after installation.

3.03 SCHEDULE OF ROOMS TO RECEIVE BLINDS

- A. All exterior windows and door lites.
- B. Interior windows.

END OF SECTION

PART 1 GENERAL

1.1 DESCRIPTION

- A. Cloth shades, manual and electrically operated, are specified in this section. Window shades shall be furnished complete, including brackets, fittings and hardware.

1.2 QUALITY CONTROL

- A. Manufacturer's Qualification: Window shade manufacturer shall provide evidence that the manufacture of shades are a major product, and that the shades have performed satisfactorily on similar installations.

1.3 SUBMITTALS

- A. Samples:
 - 1. Shade cloth, each type, 600 mm (24 inch) square, including cord and ring, showing color, finish and texture.
- B. Manufacturer's literature and data; showing details of construction and hardware for:
 - 1. Cloth and window shades

1.4 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced to in the text by the basic designation only.
- B. Federal Specifications (Fed. Spec.):
 - AA-V-00200B Venetian Blinds, Shade, Roller, Window, Roller, Slat, Cord, and Accessories
- C. American Society for Testing and Materials (ASTM):
 - A167-99(R2009) Stainless and heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip
 - B221/B221M-08 Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes
 - D635-10 Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position
 - D648-07 Deflection Temperature of Plastics under Flexural Load in the Edgewise Position
 - D1784-08 Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds

PART 2 PRODUCTS

2.1 MATERIALS

- A. Shade Cloth: translucent. As indicated in drawings.
- B. Stainless Steel: ASTM A666
- C. Cords for Venetian Blinds: No. 4 braided nylon or No. 4 1/2 braided cotton having not less than 175 pounds breaking strength.
- D. Extruded Aluminum: ASTM B221/B221M.

2.2 WINDOW SHADES

- A. Mecho Shade Corporation and Lutron Electronics Co., manually operated window shade systems.
- B. Systems: Provide all shades as complete units produced by one manufacturer, including hardware, accessory items, mounting brackets and fastenings.
- C. Manual Shade Operating System: Manual type chain operated roller shade system with adjustable slip clutch.
- D. Fabrics: Manufacturer's standard fire resistant glass cloth fabrics meeting applicable federal and state fire resistance requirements. Color and pattern as indicated, as selected by Architect from manufacturer's full range of colors and patterns where not otherwise indicated.

2.3 FABRICATION

- A. Fabricate shades to fit measurements of finished openings obtained at site.
- B. Cloth Window Shades: 3% openness. Rolling type, constructed of shade cloth mounted on rollers. Shade cloth shall have plain sides, and with hem at bottom to accommodate wood slat. Separate shades are required for each individual sash within opening. Length of shades shall exceed height of window approximately 300 mm (12 inches) measured from head to sill, in addition to material required to make up hem:
 - 1. Provide rollers with spindles, nylon bearings, tempered steel springs, and all other related accessories required for positive action. Provide rollers of diameter recommended by shade manufacturer. Staple shade cloth to wood rollers to prevent wrinkling or folding, and on line parallel to axis of rollers so that shade will hang plumb. Space staples not over 90 mm (3-1/2 inches) on centers. Use of tacks is prohibited.
 - 2. Cords shall be of sufficient length to permit shades to be drawn to bottom of opening with ends looped and held with cord rings. Attach cords to hems through metal eyelets in center of slats in bottom hems.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Cloth Window Shades: Mount window shades on end of face brackets, set on metal gussets, or casing of windows as required. Provide extension face brackets where necessary at mullions.
 - 1. Locate rollers in level position as high as practicable at heads of windows to prevent

infiltration of light over rollers.

2. Where extension brackets are necessary, on mullions or elsewhere, for alignment of shades, provide metal lugs, and rigidly anchor lugs and brackets.
3. Place brackets and rollers so that shades will not interfere with window and screen hardware.

END OF SECTION

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes: Provide nylon/rubber surface (recycled tires) entry floor mats with recessed metal frames and accessories as required for complete finished installation.

1.2 SUBMITTALS

- A. Product Data: Furnish manufacturer's literature.
- B. Shop Drawings: Furnish a large scale drawing of mat and frame with anchorage.
 - 1. Provide templates or frames to Project site in time for installation in subflooring.
- C. Samples: Submit sample mat of pattern, color and style specified.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Pawling Rubber Co.
- B. The R.C. Musson Rubber Co.
- C. American Floor Products Co. (AFCO)
- D. Marley Flexco and Etex Group Company.
- E. Or accepted equal.

2.2 MATERIALS

- A. Nylon/Rubber Mat: chenilled tire cord; 3/8" thick; 12" by 12" tiles; ribbed surface texture; manufacturer's standard color as selected by Architect.
 - 1. Type: Standard parquet pattern unless otherwise indicated.
- B. Recessed Frame: Extruded aluminum; satin finish; type designed to provide entry mats flush with adjacent floor finish.
- C. Primer: Manufacturer's standard zinc chromate primer or similar protective coating for surfaces in contact with concrete or dissimilar materials.
- D. Adhesive: Nontoxic type as recommended by manufacturer.
- E. Accessories: As required for complete, secure installation.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install frame in accordance with manufacturer's recommendations and installation

instructions.

- B. Install mats after final cleaning of flooring to receive mats.
- C. Anchor mats where required to prevent interference with wheelchair traffic.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Recessed grating system.
 - 1. Grate with bristle filament carpet tread inserts.

1.2 REFERENCES

- A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only. Refer to Section 01 42 00 "References" for definitions, acronyms, and abbreviations.
- B. Unless otherwise noted, standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes as of the date of issue of this Project Manual.
- C. Referenced Standards:
 - 1. ACI 302.1R – Guide for Concrete Floor and Slab Construction.
 - 2. ASTM B221 – Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.

1.3 SUBMITTALS

- A. Shop Drawings: Indicate locations and dimensions of recessed area to receive products specified in this section.
- B. Selection Samples: For each specified product requiring color or finish selection, submit two 12 inches by 12 inches samples illustrating selected color, finish, edging, and insert.

1.4 MAINTENANCE DATA

- A. Maintenance data: Include cleaning instructions and replacement procedures for inserts.

1.5 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide roll-up mats and frames capable of withstanding the following loads and stresses within limits and under conditions indicated:
 - 1. Uniform floor load of 300 lbf/sq. ft.
 - 2. Wheel load of 350 lb per wheel.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Manufacturer with minimum five years documented experience producing products specified in this section.
- B. Source Limitations: Obtain floor mats and frames through one source from a single manufacturer.
- C. Accessibility Requirements: Provide installed floor mats that comply with CBC and Section 4.5 in the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)."

1.7 WARRANTY

- A. Provide manufacturer's standard warranty against defects in materials and workmanship.
- B. Warranty Period: 5 years.

1.8 DELIVERY, STORAGE AND HANDLING

- A. Store Products of this section in manufacturer's unopened packaging until installation.
- B. Maintain dry, heated storage area until installation of products.

1.9 SITE CONDITIONS

- A. Field Measurements: Obtain field measurements of recessed areas to receive products of this section prior to order placement; include information on squareness and levelness of recess.
- B. Verify that field measurements are as indicated on shop Drawings.

PART 2 PRODUCTS

2.1 MANUFACTURERS AND PRODUCTS

- A. Basis-of-Design Product: Pro Tek entrance grating with RGF-300 Frame and RG-300 Drain-Well Carpet Insert by Pawling Corporation; Architectural Products Division. Provide the named product or accepted equal by one of the following:
 - 1. Arden Architectural Specialties.
 - 2. American Floor Products Company, Inc.
 - 3. C/S Group.
 - 4. Or accepted equal.
 - 5. KADEE Industries.
 - 6. Or accepted equal.
- B. Supply all products specified in this section from a single manufacturer.

2.2 MATERIALS

- A. Recessed Grating System: 1-1/2-inch deep, roll-up aluminum grate.
- B. Frame: Extruded, #6063 aluminum alloy with T52 temper per ASTM B221
 - 1. Profile: Angle, 1-1/2-inch deep leg, thickness 1/8 inch.
 - 2. Corners: Butted.
 - 3. Finish: Clear anodized finish.
 - 4. Provide all accessories recommended by manufacturer as required for a complete frame system installation.
- C. Rails:
 - 1. Material: Extruded, #6063-T52 aluminum alloy conforming to ASTM B221.
 - 2. Rail Width and Spacing: 1-inch wide rails, spaced at 1-1/2 inches on center
 - 3. Rails to run perpendicular to traffic direction.
 - 4. Rails to have continuous bottom cushions to reduce noise.
 - 5. Finish: Clear anodized finish.
- D. Hinges:

1. Low-density polyethylene hinges, with large drain holes to allow dirt and moisture to pass through the mat.
2. Hinges to be retained in a “captive” aluminum tread port.

E. Tread Inserts: Provide bristle filament carpet inserts in manufacturer’s standard color.

2.3 FABRICATION

- A. Fabricate units in the shop to greatest extent possible and in sizes indicated. Unless otherwise indicated, provide single unit for each mat installation.
- B. Coat surfaces of aluminum frames that will contact cementitious materials with manufacturer's standard protective coating.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that recesses to receive products of this section are correct size and within square tolerances and level tolerances.
3. Substrate tolerance not to exceed 1/8-inch in 10 feet, per ACI 302.1.

3.2 PREPARATION

- A. Surface preparation: Remove debris from recesses to receive grating system and vacuum clean.

3.3 INSTALLATION

- A. Install specified products in accordance with shop drawings and manufacturer’s printed installation instructions.
- B. Provide necessary shims, spacers, and anchorage to attach frames to concrete.
- C. Install grating frame to achieve flush plane with adjacent finished floor surface.
- D. Install roll-up grating in floor recess flush with adjacent finished floor after cleaning of flooring.

3.4 PROTECTION

- A. Provide temporary fillers of plywood or fiberboard in tread recesses, and cover frame with plywood for protection of grating during construction.
- B. Maintain protection until construction traffic has ended and Project is near substantial completion.

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope of Work: The Contractor shall furnish all labor, materials, tools, equipment, and transportation required to perform and complete the following work as specified herein:
1. Concrete Tables
 2. Steel Trash / Recycle Receptacles
 3. Steel Benches
 4. Bike Racks

1.2 WARRANTY

- A. Manufacturers of concrete tables, steel benches, trash, and recycling receptacles shall warrant products to be free of workmanship and material defects for five years after date of delivery.

1.3 PROTECTION

- A. Contractor shall protect existing facilities and work as needed. Contractor shall repair any damage to existing facilities and work that might occur as a result of his operations to the satisfaction of the Owner.
- B. Provide adequate means of protection from damage for products stored at the site.

1.4 SUBMITTALS

- A. Product data sheets with information on make, model, materials, dimensions, colors, finishes, specified options, and installation recommendations for:
1. Steel benches.
 2. Steel trash and recycling receptacles.
 3. Concrete tables.
 4. Bike racks

1.5 APPROVALS

- A. Contractor shall obtain Owner's written approval for colors and finishes of all products before ordering.

PART 2 - PRODUCTS

2.1 PRODUCTS

- A. Concrete table: As specified on Drawings or approved equal.
- B. Steel benches: As specified on Drawings or approved equal.
- C. Steel trash / recycle receptacles: As specified on Drawings or approved equal.

- D. Bike Rack: Dero, A Playcore Company: Round Rack. 1.5" schedule 40 pipe, powder coat, in-ground mounting

PART 3 - EXECUTION

3.1 PREPARATION

- A. Verify that weather conditions permit proper installation and curing.
- B. Verify that ground surfaces will support delivery/placement equipment. Provide adequate support to prevent damage to new and existing facilities.
- C. Verify completion and curing of concrete slabs before installation of tables, benches, and receptacles.

3.2 INSTALLATION

- A. Tables, benches, and receptacles: Install as shown and detailed on the Drawings. Verify exact location and orientation with Owner.

3.3 CLEAN UP

- A. Remove and properly dispose of debris and trash.

3.4 CLOSE OUT

- A. Provide written maintenance instructions and warranties for table, benches, and trash and recycling receptacles.

END SECTION

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes:
1. One (1) hydraulic passenger elevator.
- ~~B. Related Sections include the following:~~
- ~~1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.~~
 - ~~2. Division 03 Section "Cast-in-Place Concrete" for setting sleeves, inserts, and anchoring devices in concrete.~~
 - ~~3. Division 05 Sections "Structural Steel Framing" and "Metal Fabrications," for the following, as indicated or required:~~
 - ~~a. Attachment plates and angle brackets for supporting guide-rail brackets.~~
 - ~~b. Divider beams.~~
 - ~~c. Hoist beams.~~
 - ~~d. Structural steel shapes for subsills.~~
 - ~~e. Pit ladders.~~
 - ~~f. Cants in hoistways made from steel sheet.~~
 - ~~4. Applicable Division 26 Sections for electrical service for elevators to and including disconnect switches at machine room door. Include auxiliary contacts for signal to elevator controller indicating loss of normal power.~~
 - ~~5. Applicable Division 27 Sections for telephone service for elevators.~~
 - ~~6. Applicable Division 28 Sections for smoke detectors in elevator lobbies to initiate emergency recall operation and for connection to elevator controllers.~~

1.2 DEFINITIONS

- A. Definitions in ASME A17.1 apply to work of this Section.
- B. Defective Elevator Work: Operation or control system failure, including excessive malfunctions; performances below specified ratings; excessive wear; unusual deterioration or aging of materials or finishes; unsafe conditions; need for excessive maintenance; abnormal noise or vibration; and similar unusual, unexpected, and unsatisfactory conditions.
- C. Reference to a device or a part of the equipment applies to the number of devices or parts required to complete the installation.
- D. Substantial Completion: The work shall be considered Substantially Complete when the elevator has been inspected, a permit has been issued by the State of California Elevator Division, and the elevator has been put into operation for its intended use.
- E. Non-Proprietary: Systems that can be installed, adjusted, and repaired using on-board diagnostic features, and product manuals, and which do not require proprietary tools or manuals, and have unlimited access.

1.3 SUBMITTALS

- ~~A. General: Provide submittals as required by Div. 01~~
- ~~B.A.~~ Product Data: Include capacities, sizes, performances, operations, safety features, finishes, and similar information. Include product data for the following:

1. Operation, control, and signal systems.
2. Hydraulic power unit
3. Hydraulic control and rupture valves
4. Door operator and related hardware
5. Hydraulic jack (cylinder/plunger)
6. Microprocessor controller
7. Guide shoes
8. Signal fixtures
9. Entrance jamb floor identification plates

- G-B.** Shop Drawings: Show plans, elevations, sections, and large-scale details indicating service at each landing, machine room layout, coordination with building structure, relationships with other construction, and locations of equipment and signals. Provide details of the following:
1. Cab enclosure and hoistway entrances layouts and details.
 2. Car operating panels and hall fixtures layouts and details.
 3. Electrical requirements based on the speed and capacity specified to include maximum and average power demands.
 4. Elevator equipment cooling requirements for design of machine room cooling.
 5. Indicate variations from specified requirements, maximum dynamic and static loads imposed on building structure at points of support.
- D-C.** Submit engineering calculations for the guide rail supporting brackets, splice locations, and jack(s) support beams and brackets.
- E-D.** Submit manufacturer's recommended installation procedures which, when approved by the Consultant, shall be the basis for inspecting and accepting or rejecting actual installation.
- F-E.** Samples: For exposed finishes of cars, hoistway doors and frames, and signal equipment; 3-inch- square Samples of sheet materials; and 4-inch lengths of running trim members.
- G-F.** Operation and Maintenance Manuals: For elevators to include in emergency operations, maintenance procedures and frequency, and spare parts.
- H-G.** Inspection and Acceptance Certificates and Operating Permits: As required by authorities having jurisdiction for normal, unrestricted elevator use.

1.4 PERMIT, TESTING, AND INSPECTION

- A. Obtain and pay for permit, license, and inspection fee necessary to complete installation.
- B. Perform test required by governing authority in accordance with procedure described in CA Title 8 Elevator Safety Orders and ASME A17.2 Guide for Inspection of Elevators, Escalators, and Moving Walks, in the presence of Authorized Representative.
- C. Supply personnel and equipment for test and final review by Consultant, as required.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Elevator manufacturer or manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
- B. Regulatory Requirements:
- C. Compliance with Regulatory Agencies: Comply with most stringent applicable provisions of following codes, laws, and/or authorities, including revisions and changes in effect:

1. Safety Code for Elevators and Escalators, ASME A17.1
 2. Guide for Inspection of Elevators, Escalators, and Moving Walks, ASME A17.2
 3. Elevator and Escalator Electrical Equipment, ASME A17.5
 4. National Electrical Code, NFPA 70
 5. CCR Title 24 California Building Code
 6. CCR Title 8 Elevator Safety Orders
 7. Local Fire Authority
 8. Requirements of most stringent provision of local authority having jurisdiction
 9. Life Safety Code, NFPA101, and California Code of Regulations Title 19
- D. Accessibility Requirements: Comply with CBC Title 24 and Section 4.10 of the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)."
- E. Fire-Rated Hoistway Entrance Assemblies: Door and frame assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing at as close to neutral pressure as possible according to CBC requirements.

1.6 DESIGN CRITERIA

- A. Performance
1. Contract Speed: Within 5% of the specified speed under any loading conditions.
 2. Floor-to-floor performance time: Measured from the start of doors closing at one floor until doors are 3/4 open and the car is stopped at the next successive floor in either condition under any loading condition, based on 13'-0" floor height: 14.5 seconds
 3. Door Open Time: From start of opening to fully opened: 3.1 seconds
 4. Door Close Time: From start of closing to fully closed: 3.5 seconds
 5. Door Dwell Times: Comply with accessibility requirements and provide separate adjustable timers for car and hall calls with initial settings as follows:
 - a. Hall Calls: 5.0-6.5 seconds
 - b. Car Calls: 5.0-6.5 seconds
 - c. Interrupted Door Beam: 1.0-1.5 seconds
 6. Nudging: Adjustable with initial setting of 20 seconds. If doors fail to close after the set time, doors close at reduced speed and pressure and activate nudging buzzer.
 7. Leveling: Within 1/8-in. under any loading condition. Level into floor at all times, do not overrun floor and level back.
 8. Vertical Acceleration and Deceleration: Maximum 4 feet per second². Maximum Jerk: 8 feet per second³.
- B. Operating Qualities: The Owner's Representative will judge riding quality of car and enforce the following requirements. Make all necessary adjustments.
1. Starting and stopping shall be smooth and comfortable. Slowdown, stopping and leveling shall be without jars or bumps.
 - a. Acceleration and deceleration: Maximum 2.5 ft. per second squared
 - b. Jerk: 35 feet per second cubed
 - c. Vertical Vibration: Maximum 30 mg
 - d. Horizontal Vibration: Maximum 30 mg peak-to-peak measured at full speed for full travel in both directions
 2. Full Speed Ride: Free from vibration and sway.
- C. Motor Control: Operate at plus or minus 10% of normal feeder voltage plus or minus 3% of normal feeder frequency without damage or interruption of elevator service. Include protective devices to prevent damage on over or under voltage conditions and loss of phase or revers of phase.

- D. Sound Control:
 - 1. Vibration: Sound isolate power unit from building structure to prevent objectionable noise and vibration transmission to occupied building spaces.
 - 2. Airborne Noise: Maximum acoustical output level of:
 - a. 85 dBA measured in machine room
 - b. 65 dBA measured in elevator car during all sequences of operation
 - c. 70 dBA measured in elevator lobbies

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle materials, components and equipment in manufacturer's protective packaging.
- B. Store materials, components, and equipment off of ground, under cover, and in a dry location. Handle according to manufacturer's written recommendations to prevent damage, deterioration, or soiling.

1.8 COORDINATION

- A. Coordinate installation of sleeves, block outs, and items that are embedded in concrete or masonry for elevator equipment. Furnish templates and installation instructions and deliver to Project site in time for installation.
- B. Coordinate sequence of elevator installation with other work to avoid delaying the Work.
- C. Coordinate locations and dimensions of other work relating to hydraulic elevators including pit ladders, and sumps; entrance sill support; and electrical service, electrical outlets, lights, and switches in pits and machine rooms.

1.9 WARRANTY

- A. Manufacturer's Warranty: Manufacturer's standard form in which manufacturer agrees to repair, restore, or replace defective elevator work within specified warranty period.
 - 1. Warranty Period: One year from date of Substantial Completion.
 - 2. Provide coincidental product warranties where available for major components of elevator work. Submit with maintenance manuals.

1.10 MAINTENANCE SERVICE

- A. Warranty Maintenance:
 - 1. Provide regular elevator maintenance service for a period of one year beginning at Substantial Completion.
 - 2. The cost for Warranty Maintenance shall be included in the elevator construction contract.
 - 3. The scope of regular elevator maintenance service shall include:
 - a. Monthly (minimum) examinations to include adjustments, cleaning, and lubricating of the equipment to maintain specified performance criteria.
 - b. Callback response time for out of service elevator of one (1) hour during regular hours or two (2) hours outside normal business hours.
 - c. Callback response time for passenger entrapment of thirty (30) minutes during regular hours and one (1) hour outside normal business hours.
 - d. Monthly testing of Firefighters' Operation and emergency telephones.
 - e. Parts replacement as required using parts from the original equipment manufacturer.
 - f. Provide an on-site inventory of parts, lubricants, and supplies required to perform

the specified scope of maintenance service.

- g. Maintain a local inventory of all wearing components of the elevator system.
- h. Provide 24-hour emergency callback service at no additional cost to the owner.
- i. Maintain complete maintenance records on-site, including check charts, lubrication logs, testing and activity logs.

- B. Continuing Maintenance:
1. Provide continuing regular elevator maintenance beginning at the end of the Warranty Maintenance period.
 2. The scope of regular elevator maintenance service shall be the same as the specified scope of services under Warranty Maintenance above and shall include all testing required by local AHJ.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Elevator No. 1:
1. Type: In-ground hydraulic
 2. Rated Load: 3500 lb.
 3. Rated Speed: 125 fpm.
 4. Operation System: Selective collective automatic operation.
 5. Auxiliary Operations:
 - a. Battery-powered emergency lowering.
 - b. Independent service.
 6. Car Enclosures:
 - a. Clear Inside: 6'-8" w. x 5'-5" d. x 7'-5" h. to ceiling
 - b. Front Return: Integral entrance frame of satin stainless steel, No. 4 finish.
 - c. Side and Rear Wall Panels: Applied vertical plastic laminate panels with 3/4" reveal between panels.
 - d. Reveals: Satin stainless steel, No. 4 finish.
 - e. Door: Satin stainless steel, No. 4 finish.
 - f. Door Sills: Aluminum, mill finish.
 - g. Ceiling: Satin stainless steel, No. 4 finish with LED lighting.
 - h. Handrails: 1-1/2 inches round satin stainless steel, No. 4 finish, at rear wall.
 - i. Floor prepared to receive resilient tile (specified in Division 09 Section "Resilient Tile Flooring").
 7. Hoistway Entrances:
 - a. Width and Height: 3'-6" w. x 7'-0" h.
 - b. Type: Side-opening.
 - c. Frames: Satin stainless steel, No. 4 finish.
 - d. Doors: Satin stainless steel, No. 4 finish.
 - e. Sills: Aluminum, mill finish.
 8. Hall Fixtures: Satin stainless steel, No. 4 finish.
 9. Additional Requirements:
 - a. Provide pad buttons and one complete set of full-height quilted protection pads.

2.2 MANUFACTURERS

- A. Basis of Design: Elevator system is designed to the general requirements of standard in-ground hydraulic passenger elevators by ThyssenKrupp Elevator Co.
- B. Approved Manufacturers: Elevator equipment provided by the elevator contractor shall be as manufacturer by one of the following:
1. Hydraulic Power Units: Boremax, EECO, ThyssenKrupp

2. Controllers: Elevator Controls Corp., MCE, ThyssenKrupp
 3. Hydraulic valves: Blain, Bucher.
 4. Signal Fixtures: EPCO, ERM, Innovation, ThyssenKrupp.
 5. Door Operators: GAL, Wittur, ThyssenKrupp.
 6. Door Closers: SmarTork
 7. Door Restrictors and Gibs: Sees Inc.
- C. Substitutions: Include major components from the above listed manufacturers only. Substitution of products by other manufacturers will be considered by providing supporting documentation acceptable to the Consultant that the proposed substitutes are of equal or higher quality and performance characteristics than the specified products. Identify the source of all in the proposal.

2.3 CONTROL SYSTEM

- A. General: Provide a non-proprietary microprocessor-based control system to perform the functions of elevator motion, car operation, and door control.
1. Include sleep mode that turns car lights and fan off when there is no demand; provide adjustable time period between normal operation and activation of sleep mode.
 2. Include hardware required to connect, transfer, interrupt power, and protect motors against overloading. Properly shield each controller cabinet containing memory equipment from line pollution. Design system to accept reprogramming with minimum down time.
 3. Stop car within 1/4 inch above or below the landing sill. Maintain stopping zone regardless of load in car, direction of travel, or distance between landings.
- B. Selective Collective Operation:
1. General: Operate as a single car group from car and hall buttons located at each landing. Provide a single button at terminal landings and up and down buttons at intermediate landings. Assign cars on a real time basis using estimated time of arrival. Should one controller lose power or become inoperative, the other controller shall be capable of accepting and answering hall calls.
 2. Control: Momentary pressure on one or more car or landing buttons, other than those for the landing at which the car is standing, starts the car and causes it to stop at the first landing for which a call is registered corresponding to the direction in which the car is traveling. Stops are made in the order in which the landings are reached, regardless of the sequence in which the calls are registered.
 3. Reverse car direction only when all car calls have been answered, or all hall and car calls ahead of car and corresponding to the direction of car travel have been assigned.
 4. Slow car and stop automatically at floors corresponding to registered calls, in the order in which they are approached in direction of travel. As slowdown is initiated for a hall call, automatically cancel hall call. Cancel car calls in the same manner. Hold car at arrival floor an adjustable time interval to allow passenger transfer.
 5. Answer calls corresponding to direction in which car is traveling unless call in the opposite direction is highest (or lowest) call registered.
 6. Illuminate appropriate pushbutton to indicate call registration. Extinguish light when call is answered.
- C. Battery-Powered Lowering:
1. Upon loss of normal power, provide controls to automatically lower the car at inspection speed to the designated landing. If the car is at a floor, open the doors, and shut down. If the car is in motion between floors and lowered to the designated floor, open the doors, and shut down. If the car is in motion below the designated floor, lowered to the next lower floor, open their doors, and shut down. System includes rechargeable battery and automatic recharging system.

2. Upon restoration of normal power, the elevator shall automatically resume normal operation.
- D. Firefighters' Emergency Operation: Provide devices, equipment, and operation as required by Code.
- E. Inspection Operation: Key access and top of car station to operate elevators. Provide key switch in service cabinet to activate Inspection Operation.
- F. Independent Service: Key switch in car control station removes car from group operation and allows it to respond only to car calls. Key cannot be removed from key switch when car is in independent service. When in independent service, doors close only in response to door close button.
- G. Standby Lighting and Alarm: Car mounted battery unit with solid-state charger to operate alarm bell and car emergency lighting. Battery to be rechargeable with minimum 5-year life expectancy. Include required transformer. Provide constant pressure test button in service compartment of car operating panel. Provide lighting integral with portion of normal car lighting system.
- H. Hoistway Access: Provide key switches at top and bottom landings.

2.4 MACHINE ROOM EQUIPMENT

- A. General: Provide equipment to fit space and structural conditions shown. Permanently number equipment with numerals 4-inches high corresponding to elevator number.
- B. Controller: Wall mounted and ventilated cabinet with hinged doors for access. Provide solid-state reduced voltage starting. Provide required flow control of oil and bypass oil on initial start of pump, gradually increasing load to motor over a timed interval. Include permanently marked symbols or letters identical to wiring diagrams, adjacent to each component.
- C. Hydraulic Power Units: Self-contained dry type pump and motor. Isolate power unit from building structure with sound absorbing pads. Include thermostatically controlled tank heater to maintain oil temperature and elevator performance with minimum variation in operation, performance, and leveling.
 1. Tank: Capacity equal to plunger displacement plus 25%. Provide strainers, oil level gauge and devices to maintain uniform oil temperature including tank oil coolers.
 2. Provide variable-voltage variable-frequency motor control.
 3. Motor: Heavy duty designed for 80 starts per hour, continuous rated, of 158 degrees F (70 degrees C), rise for Class B insulation.
- D. Hydraulic Silencers: Provide hydraulic silencer containing pulsation-absorbing material in a blowout-proof housing at pump unit.
- E. Piping: All piping to be above ground. Provide piping of the size, type, and weight recommended by manufacturer. Pipe from machine room to cylinders with a minimum number of connections and 90° fittings; use 45° fittings wherever possible.
 1. Provide isolation couplings in-line at cylinder head and machine connection point. Isolate all connections and hangers.
 2. Provide flexible connectors to minimize sound and vibration transmissions from power unit.
 3. Provide shut off valves adjacent to power unit in machine room and in pit.
 4. Provide seismic bracing of oil lines.
 5. Provide threaded couplings where oil lines are located within ceiling cavities above

occupied spaces.

- F. Hydraulic Fluid: Elevator manufacturer's standard fluid with additives as needed to prevent oxidation of fluid, corrosion of cylinder and other components, and other adverse effects.

2.5 HOISTWAY EQUIPMENT

- A. Guiderails: Provide of adequate size to suit conditions shown; minimum size, 15 lbs./ft.
- B. Hoistway Switches: Provide with noiseless operation
- C. Car Frame and Platform: Welded steel units designed for Class A loading. Isolate from hydraulic jack with minimum 3/4-inch steel plates between top of plunger and car frame with one-inch rubber or neoprene isolation material between steel plate and top of the jack.
- D. Hydraulic Jack:
 - 1. Cylinder: Steel pipe, factory tested for 400-pounds/square inch working pressure. Sandblast or wire brush outside of cylinder to remove rust and scale. Provide factory paint finish.
 - 2. Plunger: Use seamless steel pipe or tubing, minimum Schedule 80. Plunger shall be no more than 0.010 inch out of round and straight within 1/16-inch. Protect during shipping and installation to avoid damage. If plunger is gouged, scarred or shows visible tool marks, it shall be replaced. Finish shall be 12 micro inches or finer. Plunger top shall be isolated from car frame.
 - 3. Platen Isolation: Provide minimum 3/4-inch steel plate between top of plunger and car frame with one-inch rubber or neoprene isolation material.
 - 4. Packing: Provide packing which inhibits leaking of oil with drip ring.
- E. Jack Hole Well and Casing:
 - 1. Well: The Elevator Contractor shall familiarize himself with existing conditions and be responsible for removing the existing jack and casing if necessary and drilling a well for installation of the new cylinder. Include a minimum of twelve (12) 55-gallon drums of spoils removal in accordance with EPA requirements.
 - 2. Casing: If required to prevent the well hole from collapse, provide steel casing sufficiently greater in diameter than the cylinder to allow for a plumb installation and of proper depth to retain hole and provide structural integrity of PVC casing. Provide minimum 10-gauge corrosion resistant well casing with watertight joints. Weld seams solid at multiple casing joints. Provide a steel ring at top of casing to be keyed into pit floor. Provide watertight seal at bottom using minimum 24-inch thick non-shrink concrete plug of appropriate type.
 - 3. Provide minimum Schedule 40 PVC casing with watertight sealed couplings, bottom end caps, and inspection ports.
 - 4. Installation: Set cylinder and PVC casing within steel casing and backfill to stabilize the bottom with clean dry sand or pea gravel. After cylinder is set, provide a watertight seal between PVC and top of cylinder. Plunger and cylinder shall be plumb within 1/16-inch.
- F. Buffers: Provide required blocking and supports.
- G. Guide Shoes: Roller type with three or more spring dampened, sound-deadening rollers per shoe. Minimum 6 inches outside diameter. Maximum roller rotation speed: 350 r.p.m.
- H. Inserts: Furnish required concrete and masonry inserts and similar anchorage devices for installing guide rails, machinery, and other components of elevator work where installation of devices is specified in another Section.

2.6 DOOR OPERATOR EQUIPMENT

- A. Operator: Manufacturer's standard closed loop machine capable of opening doors at no less than 2.5 fps. Reverse door direction upon interruption of infrared beams in no more than 2-1/2 inches of movement. Provide solid state control with closed loop circuitry to constantly monitor and automatically adjust door operation based on velocity, position, and motor current. Maintain consistent, smooth, and quiet door operation at all floors, regardless of door weight or air pressure.
- B. Door Hangers: Two-point hanger roller with neoprene roller surface and suspension with eccentric up thrust roller adjustment.
- C. Door Header and Tracks: Manufacturer's standard system designed to operate with door operator and hoistway entrances.
- D. Door Electrical Contact: Prohibit car operation unless car door is closed including door restrictor.
- E. Door Clutch: Heavy duty clutch, linkage arms, drive blocks, and pickup rollers or cams to provide positive, smooth, quiet door operation. Design clutch so car doors can be closed while hoistway doors remain open.
- F. Door Closers: Reel type closers, helical groove type design by SmarTork, ~~or approved equal~~ substitute approved by Architect.
- G. Restricted Opening Devices: New vane type door restrictors; ~~equal to~~ The Restrictor by Sees Inc. or approved equal substitute approved by Architect ~~accepted equal~~, as required by Code to prevent opening of car doors outside the unlocking zone. Plunger type restrictors are not acceptable.
- H. Infrared Reopening Device: Black, fully enclosed device recessed or flush with entrance jambs, with full screen infrared matrix or multiple beams extending vertically along leading edge of each door panel to minimum height of seven feet (7'-0") above finished floor. Device shall prevent doors from closing and reverse doors at normal opening speed if beams are obstructed while doors are closing, except during nudging operation. In event of device failure, provide for automatic shutdown of car at floor level with doors open.
 - 1. Nudging Operation: After beams of door control device are obstructed for a predetermined time interval (minimum 20.0 - 25.0 seconds), warning signal shall sound and doors shall attempt to close with a maximum of 2.5-foot pounds kinetic energy. Activation of the door open button shall override nudging operation and reopen doors.
 - 2. Interrupted Beam Time: When beams are interrupted during initial door opening, hold door open a minimum of 3.0 seconds. When beams are interrupted after the initial 3.0 second hold open time, reduce time doors remain open to an adjustable time of approximately 1.0 - 1.5 seconds after beams are reestablished.
 - 3. Differential Door Time: Provide separately adjustable timers to vary time that doors remain open after stopping in response to calls:
 - a. Car Call: Hold open time adjustable between 3.0 and 5.0 seconds.
 - b. Hall Call: Hold open time adjustable between 5.0 and 8.0 seconds. Use hall call time when car responds to coincidental calls.

2.7 WIRING

- A. General: Use only copper conductors; run in metal conduit or galvanized duct. Provide 10% spare conductors in conduit, duct, and wire runs. No splices in wiring; connect wiring directly to terminal blocks in control cabinets or junction boxes. Tag spares inside controller cabinet.

- B. Traveling cables: provide lighting, communication, and control wiring circuits in traveling cables from machine room to car connection point. Include a minimum of four (4) spare pairs of shielded communication wires. Provide means to prevent cables from rubbing or chafing against hoistway, structural beams, elevator equipment, and the car.
- C. Work light and plug receptacle: provide work light on top of car with lamp guard and plug receptacle.
- D. Conduit: where provided use EMT type conduit. Include a flexible conduit to sound isolated equipment and components.

2.8 FINISH MATERIALS

- A. General: Provide the following materials for exposed parts of elevator car enclosures, car doors, hoistway entrance doors and frames, and signal equipment as indicated.
- B. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, commercial steel, Type B, exposed, matte finish.
- C. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, commercial steel, Type B, pickled.
- D. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304.
- E. Stainless-Steel Bars: ASTM A 276, Type 304.
- F. Stainless-Steel Tubing: ASTM A 554, Grade MT 304.
- G. Aluminum Extrusions: ASTM B 221, Alloy 6063.
- H. Architectural Rubber Flooring: As manufactured by Nora Systems, Inc. and as selected by architect.

2.9 CAR ENCLOSURE

- A. General: Provide enameled-steel car enclosures to receive wall panels, with car roof, access doors, power door operators, and ventilation.
 - 1. Provide standard railings complying with ASME A17.1 on car tops where required by Code.
 - 2. Provide finished car including materials and finishes specified below.
- B. Shell: Sides and back shall be 14-gauge, textured stainless steel sheet steel. Pattern 5WL or as selected by the Architect. Provide sample.
- C. Canopy: Provide ten (10) feet clear height under canopy. Reinforced 14-gauge furniture steel or laminated construction of adequate and code-compliant strength. Underside painted reflective white. Arrange for hinged top emergency exit including lock and contact as required by Code.
- D. Suspended Ceiling and Lighting: Provide manufacture's standard, fixed metal frame, to accept drop-in ceiling panels. Panels to be translucent, white polymer diffusers with documentation of Class A fire rating. Frame to be painted black.
- E. Provide energy efficient LED lighting fixtures that adequately and uniformly illuminate the interior as required by Code.

- F. Provide clear access to the emergency exit per Code requirements.
- G. Floor Covering: 1/4 inch aluminum tread plate. Fastened to platform subfloor with concealed attachment. Route platform and position car sill for flat transition across sill.
- H. Front Return Panels and Strike Column: 14-gauge stainless steel. Return panel shall be stationary with applied type car operating panel, hinged to allow access to wiring and fixtures. Provide cabinets for special operating features and flush mounted speaker grill for the "Hands Free" telephone required by these specifications. Finish shall be 14-gauge, textured stainless steel sheet steel. Pattern 5WL or as selected by the Architect.
- I. Transoms: 14-gauge textured stainless steel finish matching front return panels and shell wall panels.
- J. Car Door Panels: Same construction as hoistway door panel. Finish shall be textured stainless steel to match front return and transom.
- K. Hand and Bumper Rails: Provide two, minimum 1/4" thick by 4" high, continuous, stainless steel, solid bar rails, with No. 4 brushed finish and returned ends, at the side and rear walls. Provide adequate mounting. Rails to be positioned with their top edges at 32 inches and 8 inches respectively, above finish floor.
- L. Pads and Hooks: Provide pad buttons and protection pads. Pad buttons shall be conspicuous type at front return panel, side and rear walls. Mount pad buttons at sides and rear above suspended ceiling line. Pads shall cover all walls and front return panel and include cutouts for access to the operating fixtures.
- M. Ventilation: Two-speed exhaust fan.

2.10 HOISTWAY ENTRANCES

- A. Complete entrances bearing fire labels from a certified testing laboratory approved by authority having jurisdiction.
- B. Frames: 14-gauge hollow metal at all floors. Bolted and lapped head to jamb assembly at all floors. Provide Arabic floor designation/Braille plates, centered at 60 inches above finished floor, on both side jambs of all entrances. Provide plates at main egress landing with "Star" designation. For designated emergency car, provide "Star of Life" cast designation plates at height of 78 inches – 84 inches above finished floor on both side jambs at all floors. Braille indications shall be below Arabic floor designation.
- C. Door Panels: 16-gauge steel, sandwich construction without binder angles. Provide leading edges of center-opening doors with rubber astragals. Provide a minimum of two heavy duty gibs per panel, one at leading and one at trailing edge with gibs in the sill groove entire length of door travel. Construct door panels with interlocking, stiffening ribs. Architectural metal cladding shall wrap around leading and trailing edge of panel and return a minimum of 1/2 inch on rear side of leading edge of panel.
- D. Sight Guards: 14-gauge, same material and finish as hoistway entrance door panels. Construct without sharp edges.
- E. Sills: Extruded aluminum.
- F. Sill Supports: Structural or formed steel designed to support door sill based upon car loading classification. Mount to eliminate need for grout under the sill.

- G. Fascia, Toe Guards and Hanger Covers: 14-gauge furniture steel with black enamel finish.
- H. Struts and Headers: Provide all support of entrances and related material to building structure. Provide door open bumpers on entrances equipped with vertical struts.
- I. Finish of Frames and Doors: Satin finish stainless steel.

**2.11 SIGNAL EQUIPMENT – BASED ON COMMON, UNRESTRICTED USE BY UNESCORTED
DETAINEES**

- A. General: Provide car and hall push buttons that illuminate white over the entire surface of the button when activated, and remain lit until call has been answered. Use LED lamps for all lighted devices and adjustable volume electronic audible signals. Provide blue illuminated lanterns and position indicators. Locate and operate devices in conformance with accessibility requirements. Provide satin stainless-steel faceplates with tamperproof fasteners.
- B. Car Operating Panels: Provide a single, swing-return type panel. Mount in front return panel adjacent to car door. Locate floor buttons in a single column with the highest button at 48 inches above the floor. Provide minimum 3/4 inch diameter raised buttons per accessibility requirements.
 - 1. Provide raised Braille and alpha characters, numerals or symbols to the left of operating buttons and devices. Raised characters shall be white on a black background with Braille designation directly below the character. Provide buttons and Braille/tactile designations in an integral, oblong design.
 - 2. Car Position Indicator: Provide illuminated, digital car position indicator, located in car operating panel including audible signal to indicate to passengers that car is either stopping at or passing each of the floors served. Include travel direction indicator.
 - 3. Alarm Bell: Pushbutton which illuminates when activated.
 - 4. Service Cabinet: Provide with concealed hinges, hairline joint, and door flush with adjacent surface. Provide door with manufacturer's standard lock cylinder, with key removable in the locked position only. Cabinet door shall include flush glazed horizontal window of required size to hold elevator operating permit. Provide all toggle switches. Service cabinet shall contain the following:
 - a. Two-speed fan switch
 - b. Light switch
 - c. Inspection switch
 - d. Stop switch
 - e. Duplex convenience outlet
 - f. Emergency light test button
 - g. Engrave car number and capacity on service cabinet door
 - 5. Emergency Communication System: Provide system that complies with ASME A17.1 and the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)." On activation, system dials preprogrammed number of monitoring station and identifies elevator location to monitoring station. System provides two-way voice communication without using a handset and provides visible signals that indicate when system has been activated and when monitoring station has responded. System is contained in flush-mounted cabinet, with identification, instructions for use, and battery backup power supply. Mount behind speaker patten in car operating panel above operating buttons.
 - 6. Firefighters' Operation Cabinet: Provide as required by code with devices and operating instructions.
- C. Hall Push-Button Stations: Provide one hall push-button station at each landing.

1. Provide buttons of the same design as car operating panels.
 2. Provide units with flat faceplate for mounting with body of unit recessed in wall.
 3. Equip units with buttons for calling elevator and for indicating desired direction of travel.
 4. Provide Firefighters' Phase I key switch and indicator light including engraved instructions in the main floor hall push button station.
 5. Provide A17.1 Appendix H pictograph and engraved instructions in hall push button station at each landing.
- D. Car Direction Lantern: Provide flush mounted discrete digital lanterns in cab entrance jamb, visible from hall push buttons with illuminated arrows and audible signal indicating direction of travel.
- E. Hall Position Indicator: Provide a digital discrete type indicator integral with hall station at main floor.
- F. Hoistway Access Switch: Provide key switch with faceplate located in entrance jamb at top and bottom entrance.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Prior to beginning installation examine elevator areas for compliance with requirements for installation tolerances and other conditions affecting performance. Verify critical dimensions and examine supporting structure and other conditions under which elevator work is to be installed.
1. Submit a written list of any dimensional discrepancies and conditions detrimental to performance.
 2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install all equipment in accordance with Contractor's instructions, referenced codes, specification, and approved submittals.
- B. Welded Construction: Provide welded connections for installing elevator work where bolted connections are not required for subsequent removal or for normal operation, adjustment, inspection, maintenance, and replacement of worn parts. Comply with AWS standards for workmanship and for qualifications of welding operators.
- C. Sound Isolation: Mount rotating and vibrating equipment on vibration-isolating mounts designed to effectively prevent transmission of vibrations to structure and thereby eliminate sources of structure-borne noise from elevator system.
- D. Lubricate operating parts of systems as recommended by manufacturers.
- E. Alignment: Coordinate installation of hoistway entrances with installation of elevator guide rails for accurate alignment of entrances with car. Where possible, delay installation of sills and frames until car is operable in shaft. Reduce clearances to minimum, safe, workable dimension at each landing.
- F. Install rails plumb and align vertically with tolerance of 1/16" in 100'-0". Secure joints without gaps and file any irregularities to a smooth surface.

- G. Manufacturer's nameplates, trademarks, or other identifying symbols not allowed on surfaces visible to the public.
- H. Leveling Tolerance: 1/4 inch, up or down, regardless of load and direction of travel.
- I. Set sills flush with finished floor surface at landing. Fill space under sill solidly with nonshrink, nonmetallic grout.
- J. Locate hall signal equipment for elevators where indicated on Drawings.

3.3 FIELD QUALITY CONTROL

- A. Acceptance Testing: On completion of elevator installation and before permitting use (either temporary or permanent) of elevators, perform acceptance tests as required and recommended by ASME A17.1 and by governing regulations and agencies.
- B. Operating Test: Load one elevator to rated capacity and operate continuously for 30 minutes over full travel distance, stopping at each level and proceeding immediately to the next. Record temperature rise of elevator oil during 30-minute test period. Record failure to perform as required.
- C. Advise Owner, Architect, and authorities having jurisdiction in advance of dates and times tests are to be performed on elevators.

3.4 PROTECTION

- A. Temporary Use: Comply with the following requirements prior to any use of the elevator for construction purposes:
 - 1. Provide car with temporary enclosure, either within finished car or in place of finished car, to protect finishes from damage.
 - 2. Provide strippable protective film on entrance and car doors and frames.
 - 3. Provide padded wood bumpers on entrance door frames covering jambs and frame faces.
 - 4. Provide other protective coverings, barriers, devices, signs, and procedures as needed to protect elevator and elevator equipment.
 - 5. Do not load elevators beyond their rated weight capacity.
 - 6. Elevator Contractor to provide full maintenance service. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as necessary for proper elevator operation at rated speed and capacity. Provide parts and supplies same as those used in the manufacture and installation of original equipment.
 - 7. Elevator Contractor to restore damaged work, if any, so no evidence remains of correction. Return items that cannot be refinished in the field to the shop, make required repairs and refinish entire unit, or provide new units as required.

3.5 CLEANING

- A. Remove oil, grease, scale, and other foreign matter from all equipment and apply one coat of field-applied machinery enamel for all equipment and metal work installed that does not have a factory applied paint or architectural finish. Neatly touch up damaged factory-painted surfaces with original paint color to protect factory finished surfaces against corrosion.
- B. Clean all architectural finishes and replace or restore any surfaces damaged during construction to like new condition.

- C. Keep work areas orderly and free from debris during progress of project. Remove all loose materials and filings resulting from work. Remove packaging materials daily.
- D. Clean hoistways, car, car enclosure, entrances, operating and signal fixtures.
- E. Clean machine room, pit equipment, and floors.

3.6 DEMONSTRATION

- A. Check operation of each elevator with Owner's personnel present and before date of Substantial Completion. Determine that operation systems and devices are functioning properly.
- B. Check operation of each elevator with Owner's personnel present not more than one month before end of warranty period. Determine that operation systems and devices are functioning properly.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Valve Boxes.
- B. Access doors.
- C. Insulation.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. This Section is part of each Division 21 Section.

1.3 ADDITIONAL REQUIREMENTS

- A. Furnish and install incidental work not shown or specified necessary to provide a complete and workable system.
- B. Make temporary connections required to maintain services during the course of the Contract without additional cost to Owner. Notify Owner seven days in advance before interrupting services.

1.4 REFERENCED STANDARDS

- A. Where material or equipment is specified to conform to referenced standards, it shall be assumed that the most recent edition of the standard in effect at time of bid shall be used.
 - 1. ANSI - American National Standards Institute.
 - 2. ASTM - American Society for Testing and Materials.
 - 3. CCR - California Code of Regulations.
 - a. Title 8 - Division of Industrial Safety, Subchapter 7; General Industry Safety Orders, Articles 31 through 36.
 - 4. NCPWB - National Certified Pipe Welding Bureau.
 - 5. CEC - California Electrical Code.
 - 6. NEMA - National Electrical Manufacturers' Association.
 - 7. NFPA - National Fire Protection Association, as amended by the CBC.
 - 8. OSHA - Occupational Safety and Health Act.
 - 9. UL - Underwriters' Laboratories, Inc.

1.5 DRAWINGS

- A. Examine Contract Documents prior to bidding of Work and report discrepancies in writing to Architect.
- B. Drawings showing location of equipment and materials are diagrammatic and job conditions will not always permit installation in location shown. The fire protection Drawings show general arrangement of equipment and materials, etc., and shall be followed as closely as existing conditions, actual building construction, and work of other trades permit.

1. Architectural and structural Drawings are part of the Work. These Drawings furnish Contractor with information relating to design and construction of the Project. Architectural Drawings take precedence over fire protection Drawings.
 2. Because of the small scale of fire protection Drawings, not all offsets, fittings, and accessories required are shown. Investigate structural and finish conditions affecting the Work and arrange Work accordingly. Provide offsets, fittings, and accessories required to meet conditions. Inform Architect immediately when job conditions do not permit installation of equipment and materials in locations shown. Obtain Architects' approval prior to relocation of equipment and materials.
 3. Relocate equipment and materials installed without prior approval of Architect. Remove and relocate equipment and materials at Contactors' expense upon Architects' direction.
 4. Minor changes in locations of equipment, piping, ducts, etc., from locations shown shall be made when directed by the Architect at no additional cost to the Owner providing such change is ordered before such items of work, or work directly connected to same are installed and providing no additional material is required.
- C. Execute work mentioned in Specifications and not shown on Drawings, or vice versa, the same as if specifically mentioned or shown in both.

1.6 REQUIREMENTS OF REGULATORY AGENCIES

- A. The publications listed below form part of this Specification. Comply with provisions of these publications except as otherwise shown or specified.
1. California Building Code, 2016.
 2. California Electrical Code, 2016.
 3. California Energy Code, 2016.
 4. California Fire Code, 2016.
 5. California Green Building Standards Code, 2016.
 6. California Mechanical Code, 2016.
 7. California Plumbing Code, 2016.
 8. California Code of Regulations, Title 24.
 9. California Health and Safety Code.
 10. CAL-OSHA.
 11. California State Fire Marshal, Title 19 CCR.
 12. National Fire Protection Association.
 13. Occupational Safety and Health Administration.
 14. Other applicable state laws.
- B. Nothing in Drawings or Specifications shall be construed to permit work not conforming to these codes, or to requirements of authorities having jurisdiction. It is not the intent of Drawings or Specifications to repeat requirements of codes except where necessary for clarity.
- C. Comply with State of California 2016 2013 Energy Code for systems, equipment, and construction.

1.7 FEES AND PERMITS

- A. Obtain and pay for permits and service required in installation of the Work. Arrange for required inspections and secure approvals from authorities having jurisdiction. Comply with the requirements of Division 1.
- B. Arrange for utility connections and pay charges incurred, including excess service charges.

1.8 UTILITY CONNECTIONS

- A. Bear the cost of construction related to utility services, from point of connection to utility services shown on Contract Documents. This includes piping, excavation, backfill, meters, boxes, check valves, backflow prevention devices, general service valves, concrete work, and the like, whether or not Work is performed by Contractor, local water/sanitation district, public utility, other governmental agencies or agencies' assigns.

1.9 FRAMING, CUTTING AND PATCHING

- A. Special framing, recesses, chases and backing for Work of this Section, unless otherwise specified, are covered under other Specification Sections.
- B. Contractor is responsible for placement of pipe sleeves, hangers, inserts, supports, and location of openings for the Work.

1.10 SUBMITTALS

- A. Provide submittal of materials proposed for use as part of this Project. Product names in Specifications and on Drawings are used as standards of quality. Furnish standard items on specified equipment at no extra cost to the Contract regardless of disposition of submittal data. Other materials or methods shall not be used unless approved in writing by Architect. Architect's review will be required even though "or equal" or synonymous terms are used. Refer to Division 01 for complete instructions.
 - 1. Partial or incomplete submittals will not be reviewed.
 - 2. Quantities are Contractor's responsibility and will not be reviewed.
 - 3. Provide materials of same brand or manufacturer for each class of equipment or material.
 - 4. Identify each item by manufacturer, brand, trade name, number, size, rating, or other data necessary to properly identify and review materials and equipment. Words "as specified" are not sufficient identification.
 - 5. Identify each submittal item by reference to items' Specification Section number and paragraph, by Drawing and detail number, and by unit tag number.
 - 6. Organize submittals in same sequence as in Specification Sections.
 - 7. Show physical arrangement, construction details, finishes, materials used in fabrications, provisions for piping entrance, access requirements for installation and maintenance, physical size, mechanical characteristics, foundation and support details, and weight.
 - a. Submit shop drawings, performance curves, and other pertinent data, showing size and capacity of proposed materials.
 - b. Specifically indicate, by drawn detail or note, that equipment complies with each specifically stated requirement of Contract Documents.
 - c. Drawings shall be drawn to scale and dimensioned (except schematic diagrams). Drawings may be prepared by vendor but must be submitted as instruments of Contractor, thoroughly checked and signed by Contractor before submission to Architect for review.
 - d. Catalog cuts and published material may be included with supplemental scaled drawings.
- B. Review of submittals will be only for general conformance with design concept and general compliance with information given in Contract Documents. Review will not include quantities, dimensions, weights or gauges, fabrication processes, construction methods, coordination with work of other trades, or construction safety precautions, which are sole responsibility of Contractor. Review of a component of an assembly does not indicate acceptance of an assembly. Deviations from Contract Documents not clearly identified by Contractor are Contractor's responsibility and will not be reviewed by Architect.

- C. Within reasonable time after award of contract and in ample time to avoid delay of construction, submit to Architect shop drawings or submittals on all items of equipment and materials provided. Provide submittal in at least seven copies and in complete package.
 - 1. Shop drawings and submittals shall include Specification Section, Paragraph number, and Contract Drawing unit symbol or detail number for reference. Organize submittals into booklets for each Specification section and submit in loose-leaf binders with index. Deviations from Contract Documents shall be clearly identified and appear at the beginning of submittal package, and shall be referenced to applicable Contract Documents requirements.
- D. Provide layouts for fire protection systems, for inclusion in coordinated layout specified in Section 23 80 00. Comply with requirements for layouts specified in Section 23 80 00.
- E. Provide coordination drawings for fire protection systems in accordance with the requirements of Specification Section 21 10 00.
- F. Furnish to Project Inspector complete installation instructions on material and equipment before starting installation.
- G. Product Data for California Green Building Standards Code Compliance: For adhesives and sealants, including primers, documentation of compliance including printed statement of VOC content and chemical components.
- H. Delegated-Design Submittal: For seismic supports, anchorages, and restraints indicated to comply with performance requirements and design criteria.
 - 1. Calculations performed for use in selection of seismic supports, anchorages, and seismic restraints shall utilize criteria indicated in Structural Contract Documents.
 - 2. Supports, anchorage and restraints for piping and equipment shall be an OSHPD pre-approved system such as Tolco, ISAT, Mason, or equal. Pipes and equipment shall be seismically restrained in accordance with requirements of current edition of California Building Code and NFPA 13. System shall have current OPA number and shall meet additional requirements of authority having jurisdiction. Provide supporting documentation required by the reviewing authority and the Architect and Engineer. Provide layout drawings showing piping, ductwork and restraint locations.
 - a. Bracing of Piping and Equipment: Specifically state how bracing attachment to structure is accomplished. Provide shop drawings indicating seismic restraints, including details of anchorage to building. In-line equipment must be braced independently of piping, and in conformance with applicable building codes. Provide calculations to show that pre-approval numbers have been correctly applied in accordance with general information notes of pre-approval documentation.
 - 3. In lieu of the above or for non-standard installations not covered in the above pre-approved systems, Contractor shall provide layout drawings showing piping, equipment, and restraint locations, and detailing supports, attachments and restraints, and furnish supporting calculations and legible details sealed by a California registered structural engineer, in accordance with California Building Code and NFPA 13.
 - 4. Additional Requirements: In addition to the above, conform to State and local requirements.

1.11 SUBSTITUTIONS

- A. Refer to Division 01 for complete instructions. Requirements given below are in addition to or are intended to amplify Division 01 requirements. In case of conflict between requirements given in this Section and those of Division 01, Division 01 requirements shall apply.

- B. It is the responsibility of Contractor to assume costs incurred because of additional work and or changes required to incorporate proposed substitute into the Project. Refer to Division 01 for complete instructions.
- C. Substitutions will be interpreted to be manufacturers other than those specifically listed in Contract Documents by brand name, model, or catalog number.
- D. Only one request for substitution will be considered for each item of equipment or material.
- E. Substitution requests shall include the following:
 - 1. Reason for substitution request.
 - 2. Complete submittal information as described herein; see "Submittals."
 - 3. Coordinated scale layout drawings depicting position of substituted equipment in relation to other work, with required clearances for operation, maintenance and replacement.
 - 4. List optional features required for substituted equipment to meet functional requirements of the system as indicated in Contract Documents.
 - 5. Explanation of impact on connected utilities.
 - 6. Explanation of impact on structural supports.
- F. Installation of reviewed substitution is Contractors' responsibility. Any mechanical, electrical, structural, or other changes required for installation of substituted equipment or material must be made by Contractor without additional cost to Owner. Review by Architect of substituted equipment or material, will not waive these requirements.
- G. Contractor may be required to compensate Architect for costs related to substituted equipment or material.

1.12 OPERATION AND MAINTENANCE MANUAL

- A. Instruct Owner's authorized representatives in operation, adjustment, and maintenance of mechanical equipment and systems. Provide three copies of certificate signed by Owner's representatives confirming that instruction is completed.
- B. Furnish three complete sets of Operating and Maintenance Manual bound in hardboard binder, and one compact disc containing complete Operating and Maintenance Manual in searchable PDF format. Provide Table of Contents. Provide index tabs for each piece of equipment in binder and disc. Start compiling data upon approval of submittals.
 - 1. Sets shall incorporate the following:
 - a. Service telephone number, address and contact person for each category of equipment or system.
 - b. Complete operating instructions for each item of fire sprinkler system.
 - 1) Original manual of NFPA-25 for fire sprinkler system.
 - c. Copies of guarantees/warrantees for each item of equipment or systems.
 - d. Test data as specified.
 - e. Typewritten maintenance instructions for each item of equipment listing lubricants to be used, frequency of lubrication, inspections required, adjustment, etc.
 - f. Manufacturers' bulletins with parts numbers, instructions, etc., for each item of equipment.
 - g. A complete list or schedule of scheduled valves giving the number of the valve, location and the rooms or area controlled by the valve. Identify each valve with a permanently attached metal tag stamped with number to match schedule. Post list in frame under plastic on wall in mechanical room or where directed by Architect.
 - h. Check test and start reports for each piece of fire protection equipment provided as part of the Work.
 - i. Commissioning and Preliminary Operation Tests required as part of the Work.

- C. Post service telephone numbers and addresses in an appropriate place designated by Architect.

1.13 SITE CONDITIONS

- A. Information on Drawings relative to existing conditions is approximate. Deviations from Drawings necessary during progress of construction to conform to actual conditions shall be approved by Architect and shall be made without additional cost to Owner. The Contractor shall be held responsible for damage caused to existing services. Promptly notify Architect if services are found which are not shown on Drawings.

1.14 WARRANTY

- A. Refer to Division 01 for warranty requirements, including effective date of warranty. Refer to specific items of equipment specified herein for warranty duration if different from that specified in Division 01.
- B. Repair or replace defective work, material, or part that appears within warranty period, including damage caused by leaks.
- C. On failure to comply with warranty requirements within a reasonable length of time after notification is given, Architect/Owner shall have repairs made at Contractor's expense.

1.15 RECORD DRAWINGS

- A. Refer to Division 01, Record Documents, for requirements governing Work specified herein.
- B. Upon completion of the Work and as precedent to final payment, deliver to Architect the following:
 - 1. Originals of drawings showing the Work exactly as installed.
 - 2. One complete set of reproducible drawings showing the Work exactly as installed.
 - 3. One compact disc with complete set of drawings in PDF format showing the Work exactly as installed.
 - 4. Provide Contractor's signature, verifying accuracy of record drawings.
- C. Obtain signature of Project Inspector for record drawings.

1.16 DELIVERY AND STORAGE

- A. Protect equipment and materials delivered to Project site from weather, humidity and temperature variations, dirt, dust and other contaminants.

1.17 COORDINATION

- A. General:
 - 1. Coordinate Work in this Section with trades covered in other Specification Sections to provide a complete and operable installation of highest quality workmanship.
- B. Electrical Coordination:
 - 1. Refer to the Electrical Drawings and Specifications, Division 26, for service voltage and power feed wiring for equipment specified in this Section. Contractor has full responsibility for the following items of work:

- a. Review the Electrical Drawings and Division 26 Specifications to verify that electrical services provided are adequate and compatible with equipment requirements.
 - b. If additional electrical services are required above that indicated on Electrical Drawings and in Division 26, such as more control interlock conductors, larger feeder, or separate 120 volt control power source, include cost to furnish and install additional electrical services as part of bid.
 - c. Prior to proceeding with installation of additional electrical work, submit detailed drawings indicating exact scope of additional electrical work.
- C. Mechanical Coordination:
1. Arrange for pipe spaces, chases, slots and openings in building structure during progress of construction, to accommodate mechanical system installation.
 2. Coordinate installation of supporting devices. Set sleeves in poured-in-place concrete and other structural components during progress of construction.
 3. Coordinate requirements for access panels and doors for mechanical items requiring access where concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 GENERAL

- A. Materials or equipment of the same type shall be of the same brand wherever possible. All materials shall be new and in first class condition.
- B. All sizes, capacities, and efficiency ratings shown are minimum.
- C. Refer to Section 21 10 00 for specific system piping materials.

2.2 MATERIALS

- A. No material installed as part of this Work shall contain asbestos.
- B. California Green Building Code Compliance:
 1. Fire protection equipment shall not contain CFCs.
 2. Fire protection equipment shall not contain Halons.

2.3 VALVE BOXES

- A. General:
 1. Where several valves or other equipment are grouped together, provide larger boxes of rectangular "vault" type adequately sized for condition and similar in construction to those specified above.
 2. Provide valve box extensions as required to set bottom of valve box tight up to top of piping in which valve is installed.
 3. Provide a tee handle wrench for each size, Alhambra Foundry Co. #A-3008, or equal.
- B. Valve Boxes in Traffic Areas: Provide Christy No. G5 traffic valve box, Brooks, or equal, 10-3/8 inches inside diameter with extensions to suit conditions, with cast iron or steel locking cover. Provide Owner with set of special wrenches or tools as required for operation of valves.

- C. Valve Boxes in Non-Traffic Areas: Provide Christy No. F22, Brooks, or equal, 8 inches inside diameter by 30 inches long, with cast iron or steel locking cover. Provide Owner with set of special wrenches or tools as required for operation of valves. Cut bottom of plastic body for operation of valves.
- D. Valve Box (Rectangular Vault Type): Precast concrete or cast iron with cast iron or steel locking type covers lettered to suit service – Brooks No. 3-TL, Christy No. B3, Fraser No. 3, Alhambra A-3004 or A-3005, Alhambra E-2202, or E-2702, or equal, with extension to suit conditions.

2.4 ACCESS DOORS

- A. Where floors, walls, or ceilings must be penetrated for access to fire protection equipment or devices, provide access doors, 14 inch by 14 inch minimum size in usable opening. Where entrance of a serviceman may be required, provide 20 inch by 30 inch minimum usable opening. Locate access doors/panels for non-obstructed and easy reach.
 - 1. Access doors less than 7'-0" above floors and exposed to public access shall have keyed locks.
- B. Access doors shall match those supplied in Division 08, except as noted in this Section.
- C. Provide stainless steel access doors for use in toilet rooms, shower rooms, kitchens and other damp areas. Provide steel access doors with prime coat of baked-on paint for other areas.
- D. Do not locate access doors in highly visible public areas such as lobbies, waiting areas, and primary entrance areas. Coordinate with Architect when access is required in these areas.
- E. Where specific information or details relating to access panels different from the above is shown or given on Drawings or other Divisions of work, that information shall supersede this specification.
- F. Manufacturers: Subject to compliance with requirements, available manufacturers offering products which may be incorporated into the Work include Milcor, Karp, Nystrom, or Cesco, equal to the following:
 - 1. Milcor:
 - a. Style K (plaster).
 - b. Style DW (gypsum board).
 - c. Style M (masonry).
 - d. Style "Fire Rated" where required.

2.5 EQUIPMENT IDENTIFICATION

- A. Identify each piece of equipment with a permanently attached engraved bakelite plate, 1/2 inch high white letters on black background.
- B. Text of Signs: Provide identification of equipment unit number, and room or area served. Coordinate name of area served with final room names and numbers for the facility. In addition, provide lettering to distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.

2.6 PIPE IDENTIFICATION

- A. Identify each piping system and indicate the direction of flow by means of Seton, Inc., Marking Services Inc., Reef Industries, Inc., or equal, pre-tensioned, coiled semi-rigid plastic pipe labels formed to circumference of pipe, requiring no fasteners or adhesive for attachment to pipe.
- B. The legends and flow arrows shall conform to ASME A13.1.

2.7 INSULATION WORK

- A. General:
 - 1. Adhesives shall comply with testing and product requirements of South Coast Air Quality Management District, Rule 1168.
 - 2. The term "piping" used herein includes pipe, valves and fittings.
 - a. Apply insulating cement to fittings, valves and strainers and trowel smooth to equal the thickness of adjacent covering. Cover with jacket to match piping. Extend covering on valves up to bonnet. Leave strainer cleanout plugs accessible.
 - b. Provide pre-formed PVC valve and fitting covers.
 - c. Provide Calcium Silicate rigid insulation and sheet metal sleeve, 18 inch minimum length at each pipe hanger. Seal ends of insulation to make vapor tight with jacket.
 - 3. Test insulation, jackets, and lap-seal adhesives as a composite product and confirm flame spread of not more than 25 and a smoke developed rating of not more than 50 when tested in accordance with UL723, ASTM E84, or NFPA 255.
 - 4. Clean thoroughly, test and have approved, piping and equipment before installing insulation and/or covering.
 - 5. Repair damage to existing pipe insulation whether or not caused during Work of the Contract, to match existing adjacent insulation for thickness and finish, but conforming to flame spread and smoke ratings specified above.
- B. Insulation of Piping:
 - 1. Insulate fire protection piping where exposed to weather for freeze protection with 1 inch thick fiberglass, minimum 3-1/2 pounds per cubic foot density, with ASJ-SSL jacket for sizes up to and including 2 inches. For larger sizes, provide 1-1/2 inches thick fiberglass, minimum 3-1/2 pounds per cubic foot density, with ASJ-SSL jacket.
 - 2. Where insulated piping is exposed to the weather apply aluminum jacket secured with 1/2 inch aluminum bands on 12 inch centers. Cover fittings with glass cloth, two coats of Foster Sealfas 30-36, and Zeston 2000, or equal, PVC fitting covers. Insulation shall be vapor tight before applying metal jacket or PVC covers.
 - a. Pipes 10 inches diameter and smaller: Minimum .016 inch thick jacket.
 - b. Pipes 12 inches diameter and larger: Minimum .020 inch thick jacket.

PART 3 - EXECUTION

3.1 ELECTRICAL REQUIREMENTS

- A. Provide adequate working space around electrical equipment in compliance with the California Electrical Code. Coordinate the fire protection Work with the electrical Work to comply.

- B. Furnish necessary control diagrams and instructions for controls. Before permitting operation of equipment which is furnished, installed, or modified under this Section, Contractor shall review associated electrical work, including overload protection devices, and assume complete responsibility for correctness of electrical connections and protective devices. Motors and control equipment shall conform to the Standards of the National Electrical Manufacturers' Association. Equipment and connections exposed to weather shall be installed in NEMA IIIIR enclosures with factory wired strip heaters in each starter enclosure and temperature control panel where required to inhibit condensation.
- C. All line voltage and low voltage wiring and conduit associated with fire protection system are included in this Section. Wiring and conduit shall comply with Division 26.

3.2 PIPING SYSTEM REQUIREMENTS

- A. Drawing plans, schematic and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

3.3 PRIMING AND PAINTING

- A. Perform all priming and painting on the equipment and materials as specified herein.
- B. Priming:
 - 1. Exposed ferrous metals, including piping, which are not galvanized or factory-finished shall be primed. Black steel pipe exposed to weather shall be painted one coat of Rust-Oleum #1069 primer for black steel piping or Rust-Oleum #5260, Kelly Moore, or equal, primer for galvanized piping.
 - 2. Metal surfaces of items to be jacketed or insulated except piping shall be given two coats of primer unless furnished with equivalent factory finish. Items to be primed shall be properly cleaned by effective means free of rust, dirt, scale, grease and other deleterious matter and then primed with the highest grade zinc rich primer. After erection or installation, primed surfaces shall be properly cleaned of foreign or deleterious matter that might impair proper bonding of subsequent paint coatings. Abrasion or other damage to shop or field prime coat shall be properly repaired and touched up with same material used for original priming.
 - 3. Where equipment is provided with nameplate data, the nameplate shall be masked off prior to painting. When painting is completed, remove masking material.
- C. See Painting Section for detailed requirements.

3.4 INSTALLATION OF PIPING SYSTEMS

- A. At time of final connection, and prior to opening valve to allow pressurization of water piping from existing systems, on site or off site, perform a pressure test to indicate static pressure of existing systems. If pressure on fire protection piping is greater than 175 psi, inform Architect immediately. Do not allow piping systems to be pressurized without written consent of the Architect.
- B. General:
 - 1. Piping shall be concealed unless shown or otherwise directed. Allow sufficient space for ceiling panel removal.
 - 2. Installation of piping shall be made with appropriate fittings. Bending of piping will not be accepted.

3. Install piping to permit application of insulation where required and to allow valve servicing.
 4. Where piping or conduit is left exposed within a room, the piping or conduit shall be run true to vertical, horizontal, or intended planes. Where possible, uniform margins are to be maintained between parallel lines and/or adjacent wall, floor, or ceiling surfaces.
 5. Horizontal runs of pipes and/or electrical conduit suspended from ceilings shall provide for maximum headroom clearance. The clearance shall not be less than 6'-6" without written approval from Architect.
 6. Close ends of pipe immediately after installation. Leave closure in place until removal is necessary for completion of installation.
 7. Each piping system shall be thoroughly flushed and proved clean before connection to equipment.
 8. Install exposed polished or enameled connections with special care showing no tool marks or threads at fittings.
 9. Install horizontal valves with valve stem above horizontal.
 10. Use reducing fittings; bushings shall not be allowed. Use eccentric reducing fittings wherever necessary to provide free drainage of lines and passage of air.
 11. Verify final equipment locations for roughing-in.
 12. Service Markers: Mark location of each plugged or capped pipe with 4 inch round by 30 inch long concrete marker, set flush with finished grade. Provide 2-1/2 inch diameter engraved brass plate as part of service marker.
 13. Where piping is installed in walls within one inch of face of stud, provide 16 gauge sheet metal shield plate on face of stud. The shield plate shall extend minimum 1-1/2 inches beyond outside diameter of pipe.
- C. Sleeves:
1. Install Adjus-to-Crete, Pipeline Seal and Insulator, or equal, pipe sleeves of sufficient size to allow for free motion of pipe, 24 gauge galvanized steel. The space between pipe and sleeves through floor slabs on ground, through outside walls above or below grade, through roof, and other locations, as directed, shall be caulked with oakum and mastic and made watertight. The space between pipe and sleeve and between sleeve and slab or wall shall be sealed watertight.
 2. At Contractor's option, Link-Seal, Metraflex Metraseal, or equal, casing seals may be used in lieu of caulking. Wrap pipes through slabs on grade with 1 inch thick fiberglass insulation to completely isolate pipe from concrete.
- D. Floor, Wall, and Ceiling Plates:
1. Fit pipes, with or without insulation, passing through walls, floors, or ceilings, and hanger rods penetrating finished ceilings with chrome-plated or stainless escutcheon plates.
- E. Firestopping:
1. Pack annular space between pipe sleeves and pipe through floors and walls with UL listed fire stop, and seal at ends. Pipe penetrations shall be UL listed, Hilti, 3M Pro-Set, or equal.
 - a. Install fire caulking behind fire protection services installed within fire rated walls, to maintain continuous rating of wall construction.
 2. Provide SpecSeal Systems UL fire rated sleeve/coupling penetrators, or equal, for each pipe penetration or fixture opening passing through floors, walls, partitions or floor/ceiling assemblies. Penetrators shall comply with UL Fire Resistance Directory (Latest Edition), and with Chapter 7, CBC requirements.
 3. Sleeve penetrators shall have built in anchor ring for waterproofing and anchoring into concrete pours or use special fit cored hole penetrator for cored holes.
 4. Copper and steel piping shall have SpecSeal plugs, or equal on both sides of penetrator to reduce noise and to provide waterproofing.
 5. All above systems to be installed in strict accordance with manufacturer's instructions.

6. Alternate firestopping systems are acceptable if approved as equal. Contractor is responsible for determining suitability of alternate products for their intended use, and shall assume all risks and liabilities in connection with the use of alternate products.

F. Flashing:

1. Flashing for penetrations of metal or membrane roof for fire protection items shall be coordinated with roofing manufacturer and roofing installer for specific roofing type utilized. The work of this section shall include furnishing, layout, sizing, and coordination of penetrations required for fire protection work.
 - a. Furnish and install flashing and counterflashing in strict conformance with requirements of the roofing manufacturer. Submit shop drawing details for review prior to installation.
 - b. Furnish and install counterflashing above each flashing required. Elmdor/Stoneman Model 1540, or equal.
2. For other types of roofing systems, furnish and install around each pipe, where pipe passes through roof, a flashing and counterflashing. Flashing shall be made of four pound seamless sheet lead with 6 inch minimum skirt and steel reinforced boot. Counterflashing shall be cast iron. Elmdor/Stoneman Model 1100-4, or equal.

G. Hangers and Supports:

1. General: Support equipment and piping so that it is firmly held in place by approved iron hangers and supports and special hangers as required. Hangers and supports shall be UL listed for fire protection service. Components shall support weight of equipment, pipe, fluid, and pipe insulation based on spacing between supports with minimum factor of safety of five based on ultimate strength of material used. Do not exceed manufacturer's load rating. Pipe attachments or hangers, shall be of same size as pipe or tubing on which used, or nearest size available. Architect shall approve hanger material before installation. Do not support piping with plumbers' tape, wire rope, wood, or other makeshift devices. Where building structural members do not match piping support spacing, provide "trapeze" (bridging) support members attached to building structural members by methods approved by structural Engineer.
 - a. Materials, design, and type numbers per Manufacturers' Standardization Society (MSS), Standard Practice (SP)-58.
2. Hanger components shall be provided by one manufacturer. B-Line, Grinnell, Tolco, Afcon, Loos & Co., Uni-Strut, or equal.
3. Hanger and Supports:
 - a. Vertical Piping: Tolco Fig. 6, or equal, clamps attached to pipe above each floor to rest on floor. Provide intermediate support for vertical piping greater than 25 feet in length.
 - b. Individually Suspended Piping: Tolco Fig. 200 or Fig. 1 Clevis, complete with threaded rod, or equal.

<u>Pipe Size</u>	<u>Rod Size</u>
4" and Smaller	3/8"
5" to 6"	5/8"

- c. Trapeze Suspension: Sch-10 or Sch-40 steel pipe trapeze member in accordance with NFPA 13- published load ratings.
- d. Pipe Clamps and Straps: B-Line B2000 or B2400, Tolco, Fig. 200 or Fig. 1, or equal. Where used for seismic support systems, provide B-line B2400, Tolco fig. 69 series retainer pipe straps, or equal.

- e. Concrete Inserts: B-line B221 continuous insert or B2500 spot insert, or equal. Do not use actuated fasteners for support of overhead piping unless approved by Architect.
 - f. Steel Connectors: Tolco Fig. 65 beam clamps with Fig. 69 retainer straps, or equal.
 - g. Deck Connectors: Afcon Fig. 610 steel ceiling plate, or equal, where approved by structural Engineer.
4. Support to Structure:
- a. Wood Structure: Provide and install wood blocking as required to suit structure. Provide lag screws or through bolts with length to suit requirements, and with size (diameter) to match the size of hanger rods required.
 - 1) Do not install Lag screws in tension without written review and acceptance by Structural Engineer.

Side Beam Angle Clip	B-Line B3062 MSS Type 34
Side Beam Angle Clip	B-Line B3060
Ceiling Flange	B-Line B3199

- 2) Blocking for support of piping shall be not less than 2 inch thick for piping up to 2 inch size. Provide 3 inch blocking for piping up through 5 inch size, and 4 inch blocking for larger piping. Provide support for blocking in accordance with Structural Engineers requirements.
 - 3) Where lag screws are used, length of screw shall be 1/2 inch less than the wood blocking. Pre-drill starter holes for each lag screw.
 - b. Steel Structure: Provide and install additional steel bracing as required to suit structure. Provide through bolts with length to suit requirements of structural components. Burning or welding on structural member may only be done if approved by Architect.
5. Pipe hanger and support spacing: Locate hangers and supports at each change of direction, within one foot of elbow, and spaced per NFPA 13, and per pipe manufacturer's listing, except as noted below.
6. Provide support for piping through roof, arranged to anchor piping solidly in place at the roof penetration.
7. Provide rigid insulation and a 12 inch long, 18 gauge galvanized sheet iron shield between the covering and the hanger whenever hangers are installed on the outside of the pipe covering.
8. Insulate copper piping from ferrous materials and hangers with two layers of 3 inch wide, 10 mil polyvinyl tape wrapped around pipe.
9. Provide a support or hanger close to each change of direction of pipe either horizontal or vertical and as near as possible to concentrated loads.
10. Suspend rods from concrete inserts with removable nuts where suspended from concrete decks. Power actuated inserts will not be allowed.

3.5 UNIONS AND FLANGES

- A. Install Watts, Epco, Nibco, or equal, dielectric unions or flanges at points of connection between copper or brass piping or material and steel pipe or material. Bushings or couplings shall not be used.
- B. Install unions in piping NPS 2" and smaller and flanges in piping NPS 2-1/2" and larger whether shown or not at each connection to equipment and tanks, and at connections to automatic valves.

- C. Locate unions for easy removal of equipment, tanks, or valves.

3.6 ACCESS DOOR

- A. Furnish and install access doors wherever required whether shown or not for easy maintenance of fire protection systems. Access doors shall provide for complete removal and replacement of equipment.

3.7 CONCRETE WORK

- A. Concrete work required for Work of this Section shall be included under another section of the Specification, unless otherwise noted, including reinforced concrete bases for pumps, tanks, compressors unless the work is specifically indicated on Drawings to be furnished under this Section.
- B. Thrust blocks, underground anchors, and pads for cleanouts, valve access boxes and washer boxes are included under this Section of the Specifications. Concrete shall be 3000 psi test minimum. Refer to Division 03 for concrete types.

3.8 PIPE IDENTIFICATION

- A. Provide temporary identification of each pipe installed, at time of installation. Temporary identification shall be removed and replaced with permanent identification as part of the Work.
- B. Apply legend and flow arrow at valve locations; at points where piping enters or leaves a wall, partition, cluster of piping or similar obstruction, at each change of direction, and at approximately 20'-0" intervals on pipe runs. Variations or changes in locations and spacing may be made with approval of Architect. There shall be at least one marking in each room. Markings shall be located for maximum visibility from expected personnel approach.
- C. Wherever two or more pipes run parallel, markings shall be supplied in the same relative location on each.
- D. Apply markings after painting and cleaning of piping and insulation is completed.

3.9 EXPANSION ANCHORS IN HARDENED CONCRETE:

- A. Refer to Structural Drawings.

3.10 TESTS AND ADJUSTMENTS

- A. Test installations in accordance with the following requirements and all applicable codes:
 1. Project Inspector should witness tests of piping systems.
 2. Notify Architect at least seven days in advance of tests.
 3. Notify local fire department of time and date of fire systems testing.
 4. Piping shall be tested at completion of roughing-in, or at other times as directed by Architect.
 5. Furnish necessary materials, test pumps, gases, instruments and labor required for testing.
 6. Isolate from system equipment that may be damaged by test pressure.
- B. Test Schedule: No loss in pressure or visible leaks shall show after four hours at pressures indicated:

<u>System Tested</u>	<u>Test Pressure PSI</u>	<u>Test With</u>
Fire Sprinkler Piping	200	Water
Compressed Air	200	Air & Non-corrosive Leak Test Fluid
Dry Standpipes	300	Water
Wet Standpipes	200	Water

1. Piping, including underground piping, connected to fire sprinkler system shall be tested and certified in accordance with NFPA requirements, except where requirements listed in this Section exceed requirements of NFPA.
 2. Non-corrosive leak test fluid shall be suitable for use with piping material specified, and with type of gas conveyed by piping system.
- C. Should material or work fail in any of these tests, it shall be immediately removed and replaced with new material, and portion of work replaced shall again be tested by Contractor at his own expense.
- D. Lubricate each item of equipment, including motors, before operation.

3.11 TRACER WIRES

- A. Provide tracer wire for non-metallic water pipe in ground outside of buildings. Use AWG #12 tracer wire with blue colored low density high molecular weight polyethylene insulation, and lay continuously on pipe so that it is not broken or stressed by backfilling operations. Secure wire to the piping with tape at 18 inch intervals. Solder all joints.
- B. Terminals: Precast concrete box and cast iron locking traffic cover, Brooks 3TL, or equal; cover marked with name of service; 6 inches of loose gravel below box. Plastic terminal board with brass bolts; identify line direction with plastic tags. Test for continuity between terminals, after backfilling, in presence of Inspector.
- C. Alternate: (use of this alternate material requires approval of authority having jurisdiction): Use electronically detectable plastic tape with metallic core, Terra Tape D, manufactured by Reef Industries, Inc., Seton, Inc., Marking Services, Inc., or equal; tape 2 inches wide, continuously imprinted "CAUTION WATER LINE BELOW". Install, with printed side up, directly over pipe, 18 inches below finish grade. Backfill material shall be as previously specified for the particular condition where pipe is installed, but avoid use of crushed rock or of earth with particles larger than 1/2 inch within the top 12 inches of backfill. Take precautions to insure that tape is not damaged or misplaced during backfill operations. Terminal boxes not required.

3.12 CHECK, TEST AND START REQUIREMENTS

- A. An authorized representative of the equipment manufacturer shall perform check, test and start of each piece of fire protection equipment. The representative may be an employee of the equipment manufacturer, or a manufacturer-certified contractor. Submit written certification from the manufacturer stating that the representative is qualified to perform the check test and start of the equipment.

1. As part of the submittal process, provide a copy of each manufacturer's printed startup form to be used.
 2. Some items of specified equipment may require that check, test and start of equipment must be performed by the manufacturer, using manufacturer's employees. See specific equipment Articles in these Specifications for this requirement.
 3. Provide all personnel, test instruments, and equipment to properly perform the check, test and start work.
 4. When work has been completed, provide copies of reports for review, prior to final observation of work.
- B. Provide copies of the completed check, test and start report of each item of equipment, bound with the Operation and Maintenance Manual.
- C. Upon completion of the work, provide a schedule of planned maintenance for each piece of equipment. Indicate frequency of service, recommended spare parts and methods for adjustment and alignment of all equipment components. Provide a copy of the schedule with each operating and maintenance manual. Provide a copy of certification from the Owner's representative indicating that they have been properly instructed in maintenance requirements for the equipment installed.

3.13 COMMISSIONING AND PRELIMINARY OPERATIONAL TESTS

- A. Prior to observation to determine final acceptance, put fire protection systems into service and check that work required has been done, including but not limited to the following condensed check list. Provide indexed report to tabulating the results of tests.
1. Equipment has been started, checked, lubricated and adjusted in accordance with manufacturer's recommendations.
 2. Correct rotation of motors and ratings of overload heaters are verified.
 3. All manufacturers' certificates of start-up specified have been delivered to Owner.
 4. All equipment has been cleaned, and damaged painted finishes touched up.
 5. Missing or damaged parts have been replaced.
 6. Flushing of piping systems has been completed and water treatment equipment, where specified, is completed.
 7. Equipment labels, pipe marker labels, ceiling markers and valve tags are installed.
 8. Valve tag schedules, corrected control diagrams, sequence of operation lists and start-stop instructions have been posted.
 9. Maintenance manuals have been delivered and Owner training has been completed.
- B. Review of Contractor's Tests:
1. Tests made by Contractor or manufacturers' representatives are subject to observation and review by Owner. Provide timely notice prior to start of each test, in order to allow for observation of testing. Upon completion of tests, provide letter to confirm that testing has been successful.
- C. Test Logs:
1. Maintain test logs listing the tests on mechanical systems showing dates, items tested, inspectors' names, remarks on success or failure of tests.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Sprinkler heads.
- B. Pipe and Fittings.
- C. Valves.
- D. Reduced pressure backflow preventer.
- E. Double check valve backflow preventer.
- F. Water flow alarm switch.
- G. Fire Department connection.
- H. Post indicator valve.
- I. Preaction (Dry) Type Sprinkler System.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 21 00 50 Basic Fire Sprinkler Materials and Methods.

1.3 REFERENCES

- A. It is the intent of these Specifications to provide for complete and operating fire protection automatic sprinkler system in full compliance with the following standards:
 - 1. National Fire Protection Association (NFPA) Standard No. 13, 2016, as amended by the CBC.
 - 2. CBC Chapter 9.
 - 3. NFPA No. 20, 2016.
 - 4. NFPA No. 24, 2016 (as amended).
 - 5. NFPA No. 25, 2013 (California Edition).
 - 6. NFPA No. 25, 2011 (California Edition).
- B. The work shall also be in accordance with all local or state requirements that apply.

1.4 DESCRIPTION OF WORK

- A. Work of this section includes, but is not necessarily limited to, the following:
- B. Furnish all coordination, labor, design drawings, calculations, materials, tools, and equipment to install the wet pipe automatic fire sprinkler system as described in this Specification Section. System shall be hydraulically calculated and designed for the building occupancy classification as determined by NFPA 13.
 - 1. The Work includes, but is not limited to the following:

- a. Complete automatic fire risers, including valves, fire department connections, flow switches, pressure switch and service mains as indicated.
 - b. Complete interior wet type automatic fire protection spray type sprinkler distribution system, including overhead service and branch mains, lateral supply piping, supports, hangers, seismic bracing, and heads
 - c. Required tests and inspections.
 - d. Provide electrical work required to complete the system. Contractor shall be responsible for providing complete and operable systems, including electrical wiring. Install wiring in conduit, in accordance with Division 26.
 - e. Protected areas shall include areas above and below the finished ceilings, exterior exposure, canopies, stairways, rooms, areaways, entry, etc, and other areas requiring sprinklers. Thoroughly examine architectural and other drawings as required to satisfy this requirement.
 - f. Tags, identification labels and instruction manuals for proper operation and maintenance.
- C. Furnish all coordination, labor, design drawings, calculations, materials, tools and equipment to install the single interlocked, supervised, pre-action automatic fire sprinkler system as described in this Specification Section. System shall be hydraulically calculated and designed for the building occupancy classification as determined by NFPA 13.
1. The Work includes, but is not limited to the following:
 - a. Complete automatic fire risers, including valves, fire department connections, flow switches, pressure switch and service mains as indicated.
 - b. Complete interior automatic pre-action fire protection spray type sprinkler distribution system, including overhead service and branch mains, lateral supply piping, supports, hangers, seismic bracing, and heads.
 - c. Required tests and inspections.
 - d. Provide electrical work required to complete the system. Contractor shall be responsible for providing complete and operable systems, including electrical wiring. Install wiring in conduit, in accordance with Division 26.
 - e. Protected areas shall include areas above and below the finished ceilings, exterior exposure, canopies, stairways, rooms, areaways, entry, etc, and other areas requiring sprinklers. Thoroughly examine architectural and other drawings as required to satisfy this requirement.
 - f. Tags, identification labels and instruction manuals for proper operation and maintenance.
- D. Provide fire sprinklers to protect combustible building overhangs greater than 4 feet wide, as required by local authority.
- E. Determine the static and residual pressure for the site as required for accurate determination of system requirements. Base system calculations on the lowest expected static and residual pressure for the area.
1. Test data for static and residual pressure shall be obtained from water district or local fire department; test shall be made within the last six months prior to start of work.
 2. Provide calculations based on 10 percent minimum safety factor. For hydraulically calculated fire sprinkler systems the maximum velocity in the building and the fire main piping shall not exceed 15 feet per second.

1.5 DRAWINGS

- A. Contractor shall thoroughly examine architectural, structural, and other Drawings provided as part of this Contract.

- B. Number of sprinkler heads indicated on Contract Drawings shall not be reduced. Provide additional heads required for coordination and to obtain approvals. Coordinate suitable head locations and spacing with Architect.

1.6 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacture of fire protection products, of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer Qualifications: A firm with at least five years of successful installation experience on projects with fire sprinkler piping systems similar to that required for this Project.
 - 1. A State of California Fire Protection Contractor's license (C-16) is required.
- C. Fire Sprinkler Fitter Certification:
 - 1. On or after January 1, 2019, automatic fire extinguishing systems sprinkler pipefitters shall be certified by Office of the State Fire Marshall (OSFM).
- D. Design Criteria: Provide complete fire protection systems as indicated and as required by authority having jurisdiction.
 - 1. When there is conflict between requirements of authority having jurisdiction or requirements of other agencies and these Drawings and Specifications, requirements of authority having jurisdiction and recommendations of standards agencies shall govern.
 - 2. Design and install entire system in accord with applicable codes, standards, and regulations.
 - 3. The automatic sprinkler system shall conform to requirements of the National Fire Protection Association, Standard No. 13, as amended by the CBC. Contractor shall hydraulically calculate sprinkler system in accordance with NFPA 13.
 - 4. Drawings are diagrammatic only to indicate rooms/areas of sprinkler protection and piping clearances when appropriate. Rerouting of pipe and addition, deletion or relocation of heads may be necessary. Submit proposed layout for approval prior to start of installation.
 - 5. FM Compliance: Comply with Factory Mutual "Approval Guide."
 - 6. Supply equipment and accessories in accordance with requirements of all applicable national, state and local codes.
 - 7. Items of a given type shall be the products of the same manufacturer.
 - 8. Scheduled equipment performance is minimum capacity required.
 - 9. Scheduled electrical capacity shall be considered as maximum available.

1.7 COORDINATION

- A. Coordinate Work in this Section with trades covered in other Sections of Specifications to provide a complete and operable installation of highest quality workmanship.
- B. Coordinate location of fire protection piping, mains and branches, to avoid interference with work by other trades. Plumbing drainage piping and ductwork shall have right-of-way over fire protection piping. Wherever conflicts exist, fire protection piping shall be offset or rerouted at no additional cost to Owner. Provide locations of piping for use in Coordinated Layout called for in Specification Section 23 80 00.
- C. Piping shall be concealed, except where so indicated or where absolutely necessary to be exposed. Exposed piping shall be placed as approved by Architect prior to installation. Heads shall be fully coordinated with architectural reflected ceiling plan and placed in center of ceiling tiles.

- D. On-site measurement of pipe will be required. Offsets, pipe, fittings, drains, etc., required to meet job conditions shall be furnished and installed at no extra cost to Owner.
- E. Additional heads required by NFPA 13 regulations shall be provided at no extra cost, if required as a result of Contractors' coordination. Location of heads and mains shall not be changed unless approved by Architect.
- F. Coordinate layout and installation of sprinklers with other construction penetrating ceilings, including light fixtures, HVAC equipment, and partition assemblies.
- G. The Architect shall decide any differences or disputes concerning coordination, interference or extent of work, and his decision shall be final.

1.8 SUBMITTALS

- A. Samples: Provide one sample of each sprinkler head type.
- B. Shop Drawings: Submit in accordance with Division 01, and as follows:
 - 1. Prepare Drawings, calculations, and product data of fire protection systems indicating pipe sized, pipe locations, fittings, shutoffs, equipment, etc. Note, in bold type, any piping which will project beyond finished surfaces of normally occupied rooms, exterior of the building or other locations which will expose the system to view.
 - 2. Layout drawings and flow calculations approved by agencies having jurisdiction.
 - 3. Drawings and calculations shall be stamped and signed by a State of California licensed professional engineer prior to submission to the Architect. Engineer shall be qualified for this work.
- C. Manufacturer's data for each item of material or equipment used.
- D. Welding operator qualification certificates.
- E. Office of the State Fire Marshall (OSFM) certification cards for automatic fire extinguishing systems sprinkler pipefitters.
- F. Test Reports: As indicated in paragraph "Tests".
 - 1. Sprinkler pressure test.
 - 2. Alarm system test.
 - 3. Underground piping test.
- G. Operation and Maintenance Manual:
 - 1. Operation and Maintenance Manual in accordance with Section 21 00 50. Include an original copy of NFPA 25, California edition, in Operation and Maintenance Manual for fire sprinkler system.
 - 2. Guarantees in accordance with Division 01.
- H. Deferred Approval Documents: Do not proceed with fabrication or installation of fire sprinkler system until deferred approval documents have been approved by regulatory agencies.
 - 1. General: Provide detailed drawings, specifications, and calculations prepared by a State of California licensed professional engineer.
 - 2. Architect Review: Make additions, changes and corrections as directed by Architect and resubmit.

3. Agency Review: Architect will submit documents to Agency or Authority Having Jurisdiction. Make additions, changes and corrections required by Agency / Authority at no cost to Owner and resubmit to Architect.
4. Agency Approval: Architect will submit documents to Agency / Authority for final approval.

1.9 APPLICABLE PUBLICATIONS

- A. The following publications form a part of this specification:
 1. ANSI - American National Standards Institute.
 2. ASME - American Society of Mechanical Engineers.
 3. UL - Underwriters' Laboratories, Inc. Fire Resistance Directory.
 4. CBC - California Building Code.
 5. NFPA National Fire Protection Standards as amended by the CBC.
 6. CFC - California Fire Code.
 7. CPC - California Plumbing Code.

1.10 SUPERVISION

- A. Keep a competent superintendent on the job that shall coordinate the activities of the crafts and maintain the progress of the work to the satisfaction of the Architect.

1.11 SITE CONDITIONS

- A. Verify all dimensions at the building site and check existing conditions before beginning work. Make changes that are necessary to coordinate the work with other trades, after review by the Architect.

1.12 REGULATIONS

- A. All work shall be installed in strict conformity with California Building Code (CBC), California Plumbing Code (CPC), and California Electric Codes (CEC), Industrial Safety Orders, California Mechanical Code (CMC), California Fire Code (CFC), and other laws and regulations of authorities having jurisdiction.

1.13 FEES AND PERMITS

- A. Take out permits and pay fees and charges required in connection with the Work.

1.14 TEMPORARY CONNECTIONS

- A. Temporary connections required to maintain services during the course of the Contract shall be made without additional cost to Owner. The normal function of the building must not be interrupted; notify Owner minimum seven days in advance before interrupting any service.

PART 2 - PRODUCTS

2.1 GENERAL

- A. The equipment to be furnished under this Specification shall be standard product of manufacturer. Where two or more units of the same class of equipment are required, these units shall be products of a single manufacturer; however, component parts of system need not be products of the same manufacturer.

2.2 MATERIALS AND EQUIPMENT

- A. Unless otherwise shown on Drawings, specified, or directed by Architect, materials and equipment used in installation of sprinkler systems shall be listed as approved by FM or UL for fire protection systems, and shall be the latest design of the manufacturer.

2.3 SPRINKLER HEADS

- A. Provide spray pattern type sprinkler heads, of ordinary degree temperature rating, except that sprinkler heads for installation in vicinity of heating equipment, and in other areas noted on Drawings, shall have temperature ratings required for such locations by NFPA 13.
- B. Sprinkler heads shall be upright, pendent, or sidewall, as required.
 - 1. Heads in ceilings of occupied spaces with recessed lights shall be chrome plated, semi-recessed pendent type, with white escutcheon.
 - 2. Sprinkler heads in rooms with surface mounted lights shall be chrome plated pendant style, with two-piece white escutcheon.
 - 3. Provide head guards in equipment rooms and storage rooms and all other locations where subject to damage.
 - 4. Upright heads in areas with no ceilings shall be rough bronze finish.
 - 5. Provide quick response type heads in light and ordinary hazard occupancies.
 - 6. Side wall heads may be used (except in extended coverage type) to cover special areas where overhead piping and heads are impractical or a considered visual problem by the Architect or Owner. Side wall heads shall be chrome finish.
 - 7. Outdoor heads, if required shall be dry or freeze resistant.
 - 8. Adjustable drop nipples are not acceptable.
- C. Recessed sprinkler heads shall have chrome finish and adjustable chrome finish escutcheons; exposed pendent heads in finished ceilings shall have chrome finish and white ceiling escutcheons. Concealed (flush) heads shall be all brass, with white cover plate.
 - 1. Provide oversized escutcheons where required to meet the requirements of ASCE 7.
- D. Spare Heads: Furnish spare heads equal to one percent of total number of heads installed under Contract, but not less than twelve. Spare head types furnished shall be representative of types and temperature ratings of heads installed, and in proportion to number of each type and temperature rating of heads installed. Furnish not less than two sprinkler head wrenches, with at least one wrench for each type of sprinkler head installed. Place spare heads and wrenches in wall mounted box manufactured for this purpose.

2.4 PIPE AND FITTINGS

- A. For Installation Aboveground: 150 PSI, Schedule 40 black steel pipe, ASTM A-53 with ductile or cast iron screwed fittings.
 - 1. Schedule 10 black steel pipe, ASTM A 135 or ASTM A 795, with grooved fittings and associated couplings may be used for pipe sizes 2 inches through 5 inches. Provide NFPA 13-specified wall thickness for pipe sizes 6 inches through 10 inches. Threading of piping will not be accepted.
- B. For Installation Underground to 12 inches Above Ground:
 - 1. Pipe and fittings shall be approved for fire protection use.
 - 2. Underground Piping Outside Building: PVC Pipe: AWWA C900 or UL 1285, Class 200, with bell end with gasket, and with spigot end. PVC Fittings: AWWA C900 or UL 1285, Class 200, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.

- a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - 1) Diamond Plastics Corporation.
 - 2) J.M. Eagle, Inc.
- 3. Underground Piping Below Building Footing and Slab: One-piece, 304 stainless steel 90-degree fitting, with AWWA C900 bell-and-spigot gasketed inlet connection with lugs on inlet end, and AWWA C606 groove on outlet end, for connection to in-building riser using AWWA C606 grooved couplers and gaskets.
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - 1) Ames Fire and Waterworks, a Watts Water Technologies Company.
 - 2) Wilkins, a Zurn Company.
- C. Standpipes: Schedule 40 galvanized steel with 300 psi galvanized fittings.
- D. Mechanical tees, saddle fittings, bushings and mechanical sprinkler head fittings shall not be used.

2.5 ENCASEMENT FOR PIPING

- A. Standard: ASTM A 674 or AWWA C105.
- B. Material: Linear low-density PE film of 0.008-inch minimum thickness.
- C. Form: Tube.
- D. Color: Natural.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - a. Northtown Pipe Protection Products; Polywrap.

2.6 VALVES

- A. Angle, Check, and Globe Valves: Fed. Spec WW-V-51; Class A, type as suitable for application.
 - 1. Select check valves for installation in vertical lines recommended by manufacturer as suitable for vertical installation. Install in vertical lines only where flow is upward.
- B. Gate Valves:
 - 1. Sizes 1-1/2 inches or less: Fed. Spec WW-V-54, Class A.
 - 2. Sizes above 1-1/2 inches: Fed. Spec WW-V-58, Class A, designation OS or OF, as required. Provide OS&Y type, 175 pound rated working pressure.
 - 3. Furnish and deliver to Owner one wrench of each size required for operating underground valves.
- C. Drain Valves: angle, or globe. Fed. Spec WW-V-51; Class A, type as suitable for application.
 - 1. UL listed and FM approved combination test and drain fittings may be used.
- D. Zone Control Valves: UL listed, outside screw and yoke or butterfly. Valves shall be sealed open with approved seal. Provide weatherproof actuator housing, with two single pole, double throw switches.

1. Supervisory Switch: Fit the control valves on the fire sprinkler risers with supervisory switch, with single pole double throw switch actuator installed to change switch position when valve is being closed.

2.7 REDUCED PRESSURE PRINCIPLE BACKFLOW PREVENTER

- A. Provide reduced-pressure principle backflow preventer assembly, including shutoff valves on inlet and outlet, and strainer on inlet, equal to Febco 860 or 880, as required. Backflow preventer shall include test cocks, and pressure differential relief valve located between two positive seating check valves. Construct in accordance with ASSE Standard 1013.
- B. Provide minimum 13 gage one or two piece expanded metal backflow preventer enclosure, sized to suit size of backflow preventer. Furnish with mounting hardware and provision for locking enclosure in closed position. Install on concrete pad, in accordance with manufacturer's installation instructions.
 1. Manufacturer: Subject to compliance with requirements and local fire and water authorities having jurisdiction, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - a. LeMeur Welding and Manufacturing: BF series.
 - b. Backflow Protection Co.: Ultimate Tuff Cage.
- C. Provide padlock and chain to lock valves in open position, and give key to Project Inspector.
 1. Padlocks shall be as specified under Section 08 70 00.
 2. Chain shall be of carbon steel, 3/8 inch wire diameter, fully welded links and weight of 140 pounds per 100 linear feet. Chain shall be hot galvanized.
- D. Provide capped connections at each test cock. Install in accordance with requirements of authority having jurisdiction.
- E. Provide water flow alarm switch at each main valve. Arrange to provide alarm if valves are closed.
- F. For units installed within buildings, provide drain, connected to unit, to collect spillage from atmospheric vent. Run drain to nearest floor sink or drain.
- G. Provide two concrete filled, 6-inch diameter pipe bollards to protect exposed piping from motor vehicle damage.
- H. Manufacturer: Subject to compliance with requirements and local fire and water authorities having jurisdiction, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 1. Ames Fire and Waterworks: A division of Watts Water Technologies, Inc.
 2. Febco: A division of Watts Water Technologies, Inc.
 3. Watts Water Technologies, Inc.
 4. Wilkins: A Zurn Company.
 5. Conbraco Industries, Inc.

2.8 DOUBLE CHECK DETECTOR VALVE BACKFLOW PREVENTERS

- A. Provide double detector check valve assembly consisting of two spring loaded brass check valves, two cast iron bronze fitted gate valves and four test cocks, equal to Febco Model 856 or 876 as required. Construct in accordance with ASSE Standard 1048.

- B. Provide minimum 13 gage one or two piece expanded metal backflow preventer enclosure, sized to suit size of backflow preventer. Furnish with mounting hardware and provision for locking enclosure in closed position. Install on concrete pad, in accordance with manufacturer's installation instructions.
 - 1. Manufacturer: Subject to compliance with requirements and local fire and water authorities having jurisdiction, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - a. LeMeur Welding and Manufacturing: BF series.
 - b. Backflow Protection Co.: Ultimate Tuff Cage.
- C. Provide padlock and chain to lock valves in open position, and give key to Project Inspector.
 - 1. Padlocks shall be as specified under Section 08 70 00.
 - 2. Chain shall be of carbon steel, 3/8 inch wire diameter, fully welded links and weight of 140 pounds per 100 linear feet. Chain shall be hot galvanized.
- D. Provide water flow alarm switch at each main valve. Arrange to provide alarm if valves are closed.
- E. For units installed within buildings, provide drain, connected to unit, to collect spillage from atmospheric vent. Run drain to nearest floor sink or drain.
- F. Provide capped connections at each test cock. Install in accordance with requirements of authority having jurisdiction.
- G. Provide two concrete filled, 6 inch diameter pipe bollards to protect exposed piping from motor vehicle damage.
- H. Manufacturer: Subject to compliance with requirements and local fire and water authorities having jurisdiction, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - 1. Ames Fire and Waterworks: a division of Watts Water Technologies, Inc.
 - 2. Febco: a division of Watts Water Technologies, Inc.
 - 3. Watts Water Technologies, Inc.
 - 4. Wilkins: a Zurn Company.
 - 5. Conbraco Industries, Inc.

2.9 WATER FLOW ALARM SWITCH

- A. UL listed water flow alarm switch suitable for variable pressure, complete with instantaneous recycling retard and two single pole double throw electrical contacts. Provide continuously monitored water flow alarm switch and trouble sensor, automatically transmitted to an approved control alarm station.

2.10 FIRE DEPARTMENT CONNECTION

- A. Post mounted, complying with Local Fire Marshal standards cast brass two-way inlet body with drop clappers. Furnish with two brass double female snoots with rigid end N.P.T.X. pin lug house thread swivels, plugs and chain.
- B. Provide check valve in piping between inlet connection and fire protection system. Provide ball drip at low point of piping, below grade on the inlet side of the check valve, and drain to gravel sump. Provide gravel sump with minimum 3 cubic feet of course gravel.

2.11 POST INDICATOR VALVE

- A. Mueller, American Cast Iron Pipe Co., or equal, UL-listed; provide handle lock and water flow alarm switch.

2.12 UNION AND FLANGES

- A. Size and Type:
 - 1. Steel 2 inches and smaller: 150 pound screwed black or galvanized malleable iron, match pipe, ground joint, brass to iron seat.
 - 2. Steel 2-1/ inches and larger: 150 pound black flange union, flat faced, full gasket.
- B. Gaskets: 1/16 inch thick rubber Garlock #122, Johns-Manville, or equal.
- C. Flange Bolts: Open hearth bolt steel, square heads, with cold pressed hexagonal nuts, cadmium plated when installed below ground. Provide copper plated steel bolts and nuts or brass bolts and nuts for brass flanges.

2.13 GAUGES

- A. Marsh "Quality Gage", U.S. Gage, Danton 800, or equal, U.L. listed, with bronze bushed movement and front recalibration. Dials shall be white with black numerals, 3-1/2 inch dial face. Normal reading shall be at midscale. Provide a three-way valve on each gauge connection.

2.14 SEISMIC SEPARATION ASSEMBLY

- A. Provide seismic separation assembly as defined in NFPA 13 at locations where piping crosses building seismic joints and at locations where required to prevent pipe breakage due to building movement.
 - 1. At Contractors option, provide Metraflex "Fireloop" UL listed assembly, or equal at each seismic joint location, in lieu of seismic separation assembly.

2.15 PREACTION (DRY) TYPE SPRINKLER SYSTEM

- A. For installation downstream of preaction valves: Schedule 40 galvanized black steel, ASTM A 53 with galvanized gray-iron threaded fittings.
 - 1. Schedule 10 galvanized black steel pipe, ASTM A 135 or ASTM A 795, with roll-grooved ends and galvanized fittings and associated couplings may be used for pipe sizes 2 inches through 5 inches. Provide NFPA 13-specified wall thickness for pipe sizes 6 inches through 10 inches. Threading of Schedule 10 galvanized black steel piping will not be accepted.
- B. Air piping for dry pipe charge shall be same as item "A" above for pre-action piping.
- C. Pre-action Valve: Vertical pattern or angle pattern; deluge type; accessories per NFPA Standards; shall include a top-loaded pneumatically closed valve, and include check valve functions. Pre-action accessories shall include a magnetically operated vent valve, actuated only by temperature detector to fill system with water. Pneumatic-hydraulic release systems are not acceptable. When the pre-action valve opens, it shall actuate fire alarm system. Provide a pressure gauge on each side of pre-action valve.

- D. Supervisory air system shall be provided for distribution piping, including an air compressor, and an air pressure sensor to activate an alarm if air pressure is lost through fusing of a head.
- E. Air Maintenance Device: In compressed air piping to the pre-action dry pipe system; Grinnell No. F-320, Central Model DU-2, or equal, downstream pressure setting as required by MFG with supply check, relief and drain valves per NFPA Standard.
- F. Solenoid Valve: ASCO Series 8210 general purpose two-way normally closed solenoid valve; brass body, Band "N" seating, 24V DC; UL listed, J.D. Gould Company, or equal.
- G. In lieu of above individual components, Contractor may use Viking "Totalpac" single interlocked pre-action system, or equal.

PART 3 - EXECUTION

3.1 GENERAL

- A. Installation of the sprinkler system shall not be started until complete plans and specifications (including water supply information and type of existing sprinkler system, if any) have been approved by the State Fire Marshal.
 - 1. Piping shall be concealed unless shown or otherwise directed.
 - 2. Where piping is left exposed within a room, it shall be run true to vertical, horizontal or intended planes. Where possible, uniform margins shall be maintained between parallel lines and/or adjacent wall, floor or ceiling surfaces.
 - 3. Horizontal runs of pipes and/or electrical conduit suspended from ceilings shall provide for maximum headroom clearance. This clearance shall not be less than 7'-6" without written approval from Architect.
 - 4. Minor changes in locations of equipment, piping, etc., from locations shown shall be made when directed by Architect at no additional cost to Owner, providing such change is ordered before such items of work, or work directly connected to same, are installed and providing no additional material is required.
 - 5. Grade all piping as required by NFPA 13.
 - 6. Close ends of pipe immediately after installation; leave closure in place until removal is necessary for completion of installation.
 - 7. Piping systems shall be thoroughly flushed and proved clean before connection to equipment.
 - 8. Pipe discharge of each drain valve to floor sink or drain.

3.2 HANGERS AND SUPPORTS

- A. General: Support piping so that it is firmly held in place by approved iron hangers and supports and by special hangers as required in accordance with NFPA 13. Hangers shall support loads specified in NFPA 13, and, in addition, shall support weight of pipe, fluid and pipe insulation, based on spacing between supports with minimum factor of safety of five based on ultimate strength of material used. Do not exceed manufacturer's load rating. Pipe attachments, or hangers, shall be of same size as pipe or tubing on which used, or nearest larger size available. Materials, design, and type numbers per Manufacturers' Standardization Society (MSS) Standard Practice SP-58, provide branch line restraints where hangers exceed 6 inches long, in accordance with NFPA 13. Install concrete anchors required. Hanger material shall be approved by Architect before installation. Do not support piping by plumbers' tape, wire, rope, wood or other makeshift devices.
- B. Suspend rods from angle clips, in accordance with Section 21 00 50.

3.3 SEISMIC REQUIREMENTS

- A. Comply with CBC, Volume 2, Chapter 16A and CBC Chapter 9 and NFPA 13.
- B. Seismic bracing system shall be a complete pre-engineered bracing system. Pre-engineered bracing system shall include plan layout, brace selection, specification, and calculations. Complete system shall be submitted to Architect for review. See Delegated Design Submittal paragraph in article, Submittals, in Section 21 00 50.
- C. Anchorage for various manufactured and fabricated items is detailed and scheduled on the drawings or specified.
 - 1. For proposed changes to anchorage shown, or specified, submit proposed methods of anchorage with calculations prepared by a California Registered Structural Engineer. Design of anchorage shall comply with the above regulations using minimum coefficients, CP, listed CBC Chapter 16A.
- D. It is not intended that prototype or non-standard equipment or equipment frames be provided. However, items of equipment shown or specified to be anchored shall maintain integrity at point of anchor after being subjected to accelerations equivalent to those established herein.
- E. Anchors: Piping shall be provided with anchors for protection of piping against damage due to earthquakes, as required by CBC Chapter 16A, NFPA 13, and other sections of this Specification.

3.4 TESTS

- A. At various stages and upon completion, the system must be tested in the presence of the enforcing agency.
- B. Upon completion and prior to acceptance of the installation, subject entire new system to tests required in NFPA 13, and furnish Owner with certificates as appropriate.

3.5 IDENTIFICATION

- A. Coordinate requirements with the authority having jurisdiction.
- B. Provide brass valve tags at each system valve, indicating valve service.
- C. Provide signage at each sprinkler valve, with sign indicating specific portion of system controlled by valve.
- D. Provide signage at each outdoor alarm device, with sign indicating which authority to call if device is activated.
- E. Prior to final acceptance, Contractor shall provide accurate color-coded Building Plan at riser location, clearly depicting fire protection system area of coverage, location of inspectors' test/drain connection and auxiliary drain connections. Provide this information at each system or building at riser location for building. Plan(s) shall be one-half size and plastic laminated.
- F. Provide hydraulic data signage permanently attached to risers, indicating location, basis of design, water supply and pressure requirements of system.

3.6 ELECTRICAL WIRING

- A. Coordination of wiring systems is part of this work. Contractor shall ensure that the following is completed.
 - 1. Work provided in other Specification Sections:
 - a. Supervised wiring to fire alarm control panel.
 - b. Supervised wiring from main waterflow indicator to fire alarm panel.
 - c. Supervised wiring from sprinkler flow switches to fire alarm panel.
 - d. Supervised wiring from valve water flow alarm switches to fire alarm panel.
 - 2. Work provided in this Specification Section:
 - a. Wiring diagrams for devices.
 - b. Other wiring not specified to provide an operating system.

3.7 SPRINKLER HEADS

- A. Heads shall be placed upright where on exposed piping, unless otherwise noted, and in pendant position on concealed piping, unless noted otherwise, with deflectors parallel to the ceiling or roof slope. Clearance between deflectors and ceilings, electric, or heating equipment, or other obstruction shall be in accordance with the requirements of NFPA 13. Provide sprinkler head guards where heads are subject to mechanical damage, for example, at mechanical rooms, and storage rooms and gymnasiums.
- B. Mount box containing spare sprinkler heads and wrenches on wall in location selected by Owner.
- C. Do not install pendent sprinkler heads until flushing of piping has been completed.
- D. Provide return bend as illustrated in NFPA 13 (NFPA exceptions do not apply) for each sprinkler head installed in finished ceiling.

3.8 INSTALLATION OF PIPING

- A. Pipe shall be assembled in accordance with the applicable requirements of NFPA 13 and NFPA 24.
- B. Install pipe encasement on underground and under-slab metal piping.
- C. Provide concrete thrust blocks for underground and underslab piping in accordance with NFPA 24 and CBC.

3.9 INSTALLATION OF VALVES

- A. All valves shall be identified by permanent metal tags or other approved means.

3.10 INSTALLATION OF DRAINS

- A. Auxiliary drains shall be installed on low points in each system.
 - 1. Five or fewer trapped gallons will not require a drain valve but may be drained through a plugged fitting. Drain valves shall be in accordance with the requirements of NFPA 13.
- B. Install one inspector's test drain on sprinkler system. Extend drain to outside in location approved by Architect. Water discharge shall be positioned such that landscaping will not be damaged.

- C. Drain valves shall be piped to a safe place of discharge and discharge shall be visible either by open-end drainpipe or sight drain fitting.
- D. Provide flushing connections at ends of cross-mains.

3.11 INSTALLATION OF BACKFLOW PREVENTERS

- A. Install backflow preventers where indicated on Drawings. Provide available manufacturers drain connection, pipe drain outlet to nearest floor sink or drain.
 - 1. Where drain pans are shown on Drawings, pipe drain pan outlet to nearest floor sink or drain.

3.12 SLEEVES

- A. Install AMI Products, Adjus-to-Crete, or equal, pipe sleeves of sufficient size to allow for free motion of pipe, 24 gauge galvanized steel. The space between pipe and sleeves through floor slabs on ground, through outside walls above or below grade, through roof, and other locations as directed shall be caulked with oakum and mastic and made watertight. The space between pipe and sleeve and between sleeve and slab or wall shall be sealed watertight.
- B. At walls below grade Link-Seal casing seals, or equal, may be used in lieu of caulking. Pipes penetrating walls below grade shall be anchored at wall.

3.13 FLOOR, WALL, AND CEILING PLATES

- A. Fit pipes with or without insulation passing through walls, floors, or ceilings and hanger rods penetrating finished ceilings with chrome plated or stainless steel plates.

3.14 FIRESTOPPING

- A. The annular space between pipe sleeves and pipe passing through all floors and walls shall be packed with incombustible mastic or other suitable material, in accordance with U.L. Fire Resistance Directory.
- B. Penetrations in fire rated assemblies shall also be protected in accordance with CBC Chapter 7, Section 712, and UL Fire Resistance Directory.

3.15 UNION AND FLANGES

- A. Install unions whether shown or not at each connection to equipment and at one connection to each valve or cock.
- B. Locate the unions for easy removal of the equipment or valve.

3.16 CLEANING

- A. Upon completion of tests, clean equipment, piping, etc., installed under this Section of the Specifications.

3.17 FLUSH

- A. Entire system shall be flushed out and cleaned after completion of piping, and prior to installation of sprinkler heads. Flush shall be continued until water runs clear at drain connections.

3.18 PRE-ACTION SYSTEM

- A. Function of System: Conform to requirements of NFPA 13 and the following:
 1. The single interlocked pre-action system shall utilize a detector system and pressurized air in sprinkler piping.
 2. The system shall utilize deluge valve and be arranged so that deluge valve will open only when there is operation of detection system.
 3. If detection system operates due to fire, damage or a malfunction, deluge valve shall open.
 4. If sprinkler piping is damaged or sprinkler is broken or fused, deluge valve shall not open.
 5. The operation of a detector (or release) shall be required before deluge valve will open, allowing water to enter system piping.
 6. Provide system override to allow deluge valve operation should detection system be rendered inoperative.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Electric motors.
 - 2. Motor starters.
 - 3. Strainers.
 - 4. Valve boxes.
 - 5. Gauges.
 - 6. Thermometers.
 - 7. Access Doors.
 - 8. Expansion loops.
 - 9. Flexible joints.
 - 10. Insulation.

1.2 RELATED REQUIREMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. This Section is a part of each Division 22 Section.

1.3 ADDITIONAL REQUIREMENTS

- A. Furnish and install any incidental work not shown or specified which is necessary to provide a complete and workable system.
- B. Make all temporary connections required to maintain services during the course of this Contract without additional cost to the Owner. Notify the Owner seven days in advance before disturbing any service.
- C. Plumbing work done under this contract shall not adversely affect the operation of the existing plumbing systems.

1.4 REFERENCES AND STANDARDS

- A. Where material or equipment is specified to conform to referenced standards, it shall be assumed that the most recent edition of the standard in effect at the time of bid shall be used.
 - 1. CSA – Canadian Standards Association International.
 - 2. ANSI - American National Standards Institute.
 - 3. ASTM - American Society for Testing and Materials.
 - 4. CCR - California Code of Regulations.
 - a. Title 8 - Division of Industrial Safety, Subchapter 7; General Industry Safety Orders, Articles 31 through 36.
 - 5. NCPWB - National Certified Pipe Welding Bureau.
 - 6. CEC - California Electrical Code.
 - 7. NEMA - National Electrical Manufacturers' Association.
 - 8. NFPA - National Fire Protection Association.
 - 9. OSHA - Occupational Safety and Health Act.
 - 10. UL - Underwriters' Laboratories, Inc.

- B. Requirements of Regulatory Agencies:
1. The publications listed below form part of this specification; comply with provisions of these publications except as otherwise shown or specified.
 - a. California Building Code, 2019.
 - b. California Electrical Code, 2019.
 - c. California Energy Code, 2019.
 - d. California Fire Code, 2019.
 - e. California Green Building Standards Code, 2019.
 - f. California Mechanical Code, 2019.
 - g. California Plumbing Code, 2016.
 - h. California Plumbing Code, 2019.
 - i. California Code of Regulations, Title 24.
 - j. California Health and Safety Code.
 - k. CAL-OSHA.
 - l. California State Fire Marshal, Title 19 CCR.
 - m. National Fire Protection Association.
 - n. Occupational Safety and Health Administration.
 - o. Other applicable state laws.
 2. Nothing in Drawings or specifications shall be construed to permit work not conforming to these codes, or to requirements of authorities having jurisdiction. It is not the intent of Drawings or specifications to repeat requirements of codes except where necessary for clarity.

1.5 DRAWINGS

- A. Examine Contract Documents prior to bidding of work and report discrepancies in writing to Architect.
- B. Drawings showing location of equipment and materials are diagrammatic and job conditions will not always permit installation in location shown. The Plumbing Drawings show general arrangement of equipment and materials, etc., and shall be followed as closely as existing conditions, actual building construction, and work of other trades permit.
1. Architectural and Structural Drawings shall be considered part of the Work. These Drawings furnish Contractor with information relating to design and construction of the Project. Architectural Drawings take precedence over Plumbing Drawings.
 2. Because of the small scale of Plumbing Drawings, not all offsets, fittings, and accessories required are shown. Investigate structural and finish conditions affecting the Work and arrange Work accordingly. Provide offsets, fittings, and accessories required to meet conditions. Inform Architect immediately when job conditions do not permit installation of equipment and materials in the locations shown. Obtain the Architects approval prior to relocation of equipment and materials.
 3. Relocate equipment and materials installed without prior approval of the Architect. Remove and relocate equipment and materials at Contractors' expense upon Architects' direction.
 4. Minor changes in locations of equipment, piping, etc., from locations shown shall be made when directed by the Architect at no additional cost to the Owner providing such change is ordered before such items of work, or work directly connected to same are installed and providing no additional material is required.
- C. Execute work mentioned in Specifications and not shown on Drawings, or vice versa, the same as if specifically mentioned or shown in both.

1.6 FEES AND PERMITS

- A. Obtain and pay for all permits and service required in installation of this work; arrange for required inspections and secure approvals from authorities having jurisdiction. Comply with requirements of Division 01.
- B. Arrange for utility connections and pay charges incurred, including excess service charges.
 - 1. Bear the cost of construction related to utility services, from point of connection to utility services shown on Contract Documents. This includes piping, excavation, backfill, meters, boxes, check valves, backflow prevention devices, general service valves, concrete work, and the like, whether or not Work is performed by Contractor, local water/sanitation district, public utility, other governmental agencies or agencies' assigns.
- C. Prior to the start of construction, contact local gas company representative and coordinate location of gas meter and piping. In addition, coordinate time required for installation, in order to avoid delay to the Project.
- D. Coordination:
 - 1. General:
 - a. Coordinate plumbing Work with trades covered in other Specifications Sections to provide a complete, operable and sanitary installation of the highest quality workmanship.
 - 2. Electrical Coordination:
 - a. Refer to the Electrical Drawings and Specifications, Division 26, for service voltage and power feed wiring for equipment specified under this section. Contractor has full responsibility for the following items of work:
 - 1) Review the Electrical Drawings and Division 26 Specifications to verify that electrical services provided are adequate and compatible with equipment requirements.
 - 2) If additional electrical services are required above that indicated on Electrical Drawings and in Division 26, such as more control interlock conductors, larger feeder, or separate 120 volt control power source, include cost to furnish and install additional electrical services as part of the bid.
 - 3) Prior to proceeding with installation of additional electrical work, submit detailed drawings indicating exact scope of additional electrical work.
 - 3. Mechanical Coordination:
 - a. Arrange for pipe spaces, chases, slots and openings in building structure during progress of construction, to accommodate mechanical system installation.
 - b. Coordinate installation of supporting devices. Set sleeves in poured-in-place concrete and other structural components during progress of construction.
 - c. Coordinate requirements for access panels and doors for mechanical items requiring access where concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."
 - d. Coordinate with other trades equipment locations, pipe, duct and conduit runs, electrical outlets and fixtures, air inlets and outlets, and structural and architectural features. Provide information on location of piping and seismic bracing to other trades as required for a completely coordinated project.

1.7 SUBMITTALS - GENERAL

- A. Refer to Division 01 Submittals Section(s) for additional requirements.
- B. Submittal packages may be submitted via email as PDF electronic files, or as printed packages. PDFs shall be legible at actual size (100 percent). Provide seven copies of printed submittal packages.

- C. Provide submittal of materials proposed for use as part of this Project. Product names in Specifications and on Drawings are used as standards of quality. Furnish standard items on specified equipment at no extra cost to the Contract regardless of disposition of submittal data. Other materials or methods shall not be used unless approved in writing by Architect. Architect's review will be required even though "or equal" or synonymous terms are used.
1. Partial or incomplete submittals will not be considered.
 2. Quantities are Contractor's responsibility and will not be reviewed.
 3. Provide materials of the same brand or manufacturer for each class of equipment or material.
 4. Identify each item by manufacturer, brand, trade name, number, size, rating, or other data necessary to properly identify and review materials and equipment. Words "as specified" are not sufficient identification.
 5. Identify each submittal item by reference to items' Specification Section number and paragraph, by Drawing and detail number, and by unit tag number.
 6. Organize submittals in same sequence as in Specification Sections.
 7. Show physical arrangement, construction details, finishes, materials used in fabrications, provisions for piping entrance, access requirements for installation and maintenance, physical size, mechanical characteristics, foundation and support details, and weight.
 - a. Submit Shop Drawings, performance curves, and other pertinent data, showing size and capacity of proposed materials.
 - b. Specifically indicate, by drawn detail or note, that equipment complies with each specifically stated requirement of Contract Documents.
 - c. Drawings shall be drawn to scale and dimensioned (except schematic diagrams). Drawings may be prepared by vendor but must be submitted as instruments of Contractor, thoroughly checked and signed by Contractor before submission to Architect for review.
 - d. Catalog cuts and published material may be included with supplemental scaled drawings.
- D. Review of submittals will be only for general conformance with design concept and general compliance with information given in Contract Documents. Review will not include quantities, dimensions, weights or gauges, fabrication processes, construction methods, coordination with work of other trades, or construction safety precautions, which are sole responsibility of Contractor. Review of a component of an assembly does not indicate acceptance of an assembly. Deviations from Contract Documents not clearly identified by Contractor are Contractor's responsibility and will not be reviewed by Architect.
- E. Within reasonable time after award of contract and in ample time to avoid delay of construction, submit to Architect Shop Drawings or submittals on all items of equipment and materials provided. Provide submittal in at least seven copies and in complete package.
1. Shop Drawings and submittals shall include Specification Section, Paragraph number, and Drawing unit symbol or detail number for reference. Organize submittals into booklets for each Specification section and submit in loose-leaf binders with index. Deviations from the Contract Documents shall be prominently displayed in the front of the submittal package and referenced to the applicable Contract requirement.
- F. Furnish to the Project Inspector complete installation instructions on material and equipment before starting installation.

1.8 ACTION SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for plumbing systems materials and products.
- B. Shop Drawings.

- C. Provide product data for insulation products, including insulation, insulation facings, jackets, adhesives, sealants, and coatings, indicating compliance with requirement that these products contain less than 0.1 percent (by mass) polybrominated diphenyl ethers (PBDEs) in penta, octa, or deca formulations.
- D. Pipe, pipe or plumbing fittings, fixtures, solder and flux installed in a system providing water for human consumption shall comply with lead free requirements of the California Health and Safety Code Section 11 68 75. Provide submittal information for products third-party certified by an approved laboratory as complying with California Health and Safety Code Section 11 68 75.
- E. Delegated-Design Submittals: For seismic supports, anchorages, restraints, and vibration isolators indicated to comply with performance requirements and design criteria.
 - 1. Calculations performed for use in selection of seismic supports, anchorages, and restraints shall utilize criteria indicated in Structural Contract Documents.
 - 2. Include design calculations and details for selecting vibration isolators and vibration isolation bases complying with performance requirements, design criteria, and analysis data signed and sealed by the California registered structural engineer responsible for their preparation.
 - 3. Supports, anchorages and restraints for piping, ductwork, and equipment shall be an OSHPD pre-approved system such as TOLCO, ISAT, Mason, or equal. Pipes, ducts and equipment shall be seismically restrained in accordance with requirements of current edition of California Building Code. System shall have current OPM number and shall meet additional requirements of authority having jurisdiction. Provide supporting documentation required by the reviewing authority and the Architect and Engineer. Provide layout drawings showing piping, ductwork and restraint locations.
 - a. Bracing of Piping and Equipment: Specifically state how bracing attachment to structure is accomplished. Provide shop drawings indicating seismic restraints, including details of anchorage to building. In-line equipment must be braced independently of piping, and in conformance with applicable building codes. Provide calculations to show that pre-approval numbers have been correctly applied in accordance with general information notes of pre-approval documentation.
 - b. In lieu of the above or for non-standard installations not covered in the above pre-approved systems, Contractor shall provide layout drawings showing piping, ductwork, and restraint locations, and detail supports, attachments and restraints, and furnish supporting calculations and legible details sealed by a California registered structural engineer, in accordance with 2019 California Building Code
 - 4. Additional Requirements: In addition to the above, conform to all state and local requirements.

1.9 INFORMATIONAL SUBMITTALS

- A. Provide layouts for plumbing systems, for inclusion in coordinated layout specified in Section 23 80 00. Comply with requirements for layouts specified in Section 23 80 00.

1.10 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data:
 - 1. Refer to Division 01 for complete instructions.
 - 2. Furnish three complete sets of Operation and Maintenance Manual bound in hardboard binder, and one compact disc containing complete Operation and Maintenance Manual in searchable PDF format. Provide Table of Contents. Provide index tabs for each piece of equipment in binder and disc. Begin compiling data upon approval of submittals.

- a. Sets shall incorporate the following:
 - 1) Product Data.
 - 2) Shop Drawings.
 - 3) Record Drawings.
 - 4) Service telephone number, address and contact person for each category of equipment or system.
 - 5) Complete operating and maintenance instructions for each item of plumbing equipment and systems.
 - 6) Copies of guarantees/warrantees for each item of equipment and systems.
 - 7) Test data and system balancing reports.
 - 8) Typewritten maintenance instructions for each item of equipment listing lubricants to be used, frequency of lubrication, inspections required, adjustment, etc.
 - 9) Manufacturers' bulletins with parts numbers, instructions, etc., for each item of equipment.
 - 10) Control diagrams and literature.
 - 11) Check test and start reports for each piece of plumbing equipment provided as part of the Work.
 - 12) Commissioning and Preliminary Operation Tests required as part of the Work.
 - b. Post service telephone numbers and/or addresses in an appropriate place as designated by the Architect.
- B. Record Drawings:
1. Refer to Division 01, Record Documents, for requirements governing Work specified herein.
 2. Upon completion of the work, deliver to Architect the following:
 - a. Originals of drawings showing the Work exactly as installed.
 - b. One complete set of reproducible drawings showing the Work exactly as installed.
 - c. One compact disc with complete set of drawings in PDF format showing the Work exactly as installed.
 - d. Provide Contractor's signature, verifying accuracy of record drawings.
 - e. Obtain the signature of the Project Inspector for all record drawings.

1.11 SUBSTITUTIONS

- A. Refer to Division 01 for complete instructions. Requirements given below are in addition to or are intended to amplify Division 01 requirements. In the case of conflict between requirements given herein and those of Division 01, Division 01 requirements shall apply.
- B. It is the responsibility of Contractor to assume costs incurred because of additional work and or changes required to incorporate proposed substitute into the Project. Refer to Division 01 for complete instructions.
- C. Substitutions will be interpreted to be all manufacturers other than those specifically listed in the Contract Documents by brand name, model or catalog number.
- D. Only one request for substitution will be considered for each item of equipment or material.
- E. Substitution requests shall include the following:
 1. Reason for substitution request.
 2. Complete submittal information as described herein; see "Submittals."
 3. Coordinated scale layout drawings depicting position of substituted equipment in relation to other work, with required clearances for operation, maintenance and replacement.
 4. List optional features required for substituted equipment to meet functional requirements of the system as indicated in Contract Documents.

- 5. Explanation of impact on connected utilities.
- 6. Explanation of impact on structural supports.

- F. Installation of reviewed substitution is the Contractors' responsibility. Any mechanical, electrical, structural, or other changes required for installation of reviewed substituted equipment or material must be made by the Contractor without additional cost to the Owner. Review by the Architect of the substituted equipment or material, including dimensioned Drawings will not waive these requirements.

- G. Contractor may be required to compensate the Architect for costs related to substituted equipment or material.

1.12 QUALITY ASSURANCE

- A. **Manufacturer's Qualifications:** Firms regularly engaged in manufacture of plumbing systems products, of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

- B. **Contractor's Qualifications:** Firm with at least 5 years of successful installation experience on projects with plumbing systems work similar to that required for this Project.

- C. **California Health and Safety Code Compliance:** For products covered under the scope of HSC 116875 for potable water service. Products for potable water service shall be third-party certified by an approved laboratory as complying with California Health and Safety Code Section 11 68 75.

- D. Comply with applicable portions of California Plumbing Code pertaining to selection and installation of plumbing materials and products.

- E. All materials and products shall be new and shall match existing.

1.13 DELIVERY, STORAGE, AND HANDLING

- A. Protect equipment and piping delivered to Project site from weather, humidity and temperature variations, dirt, dust and other contaminants.

1.14 FIELD CONDITIONS

- A. Information on Drawings relative to existing conditions is approximate. Deviations from Drawings necessary during progress of construction to conform to actual conditions shall be approved by the Architect and shall be made without additional cost to the Owner. The Contractor shall be held responsible for damage caused to existing services. Promptly notify the Architect if services are found which are not shown on Drawings.

1.15 WARRANTY

- A. Refer to Division 01 for warranty requirements, including effective date of warranty. Refer to specific items of equipment specified herein for warranty duration if different from that specified in Division 01.

- B. Repair or replace defective work, material, or part that appears within the warranty period, including damage caused by leaks.

- C. On failure to comply with the above warranty within a reasonable length of time after notification is given, the Architect/Owner shall have the repairs made at the Contractor's expense.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Materials or equipment of the same type shall be of the same brand wherever possible. All materials shall be new and in first class condition.
- B. All sizes, capacities, and efficiency ratings shown are minimum, except that gas capacity is maximum available.
- C. Refer to Sections 22 10 00 and 23 80 00 for specific system piping materials.

2.2 MATERIALS AND PRODUCTS

- A. No material installed as part of this Work shall contain asbestos.
- B. Insulation products, including insulation, insulation facings, jackets, adhesives, sealants and coatings shall not contain polybrominated diphenyl ethers (PBDEs) in penta, octa, or deca formulations in amounts greater than 0.1 percent (by mass).

2.3 ELECTRIC MOTORS

- A. General Motor Requirements: Comply with NEMA MG 1 unless otherwise indicated. Comply with IEEE 841 for severe-duty motors.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - a. U.S. Motors.
 - b. Century Electric.
 - c. General Electric.
 - d. Lincoln.
 - e. Gould.
- B. Motor Characteristics: Designed for continuous duty at ambient temperature of 40 deg. C and at altitude of 3300 feet above sea level. Capacity and torque shall be sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.
 - 1. Motors exceeding the nameplate amperage shall be promptly replaced at no cost to the Owner. Horsepower shown is minimum and shall be increased as necessary to comply with above requirements. Furnish motors with splash-proof or weatherproof housings, where required or recommended by the manufacturer. Match the nameplate voltage rating with the electrical service supplied. Check Electrical Drawings. Provide a transformer for each motor not wound specifically for system voltage.
- C. Polyphase Motors: NEMA MG 1, Design B, medium induction motor, premium efficiency as defined in NEMA MG 1. Select motors with service factor of 1.15. Provide motor with random-wound, squirrel cage rotor, and permanently lubricated or regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading. Temperature rise shall match insulation rating. Provide Class F insulation.
 - 1. Multispeed motors shall have separate windings for each speed.

- D. Polyphase Motors with Additional Requirements:
 - 1. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
 - 2. Motors Used with Variable Frequency Controllers:
 - a. Separately Connected Motors: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
 - b. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
 - c. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
 - d. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
 - e. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
 - f. Each motor shall be provided with a shaft grounding device for stray current protection.
 - 3. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.
- E. Single-Phase Motors:
 - 1. Select motors with service factor of 1.15.
 - 2. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
 - a. Permanent-split capacitor.
 - b. Split phase.
 - c. Capacitor start, inductor run.
 - d. Capacitor start, capacitor run.
 - 3. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
 - 4. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
 - 5. Motors 1/20 HP and Smaller: Shaded-pole type.
- F. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

2.4 MOTOR STARTERS

- A. Square D, Allen Bradley, or equal, in NEMA Type 1 enclosure, unless otherwise specified or required. Minimum starter size shall be Size 1. Provide NEMA 3R enclosure where exposed to outdoors.
- B. Provide magnetic motor starters for equipment provided under the Mechanical Work. Starters shall be non-combination type. Provide part winding or reduced voltage start motors where shown or as hereinafter specified. Minimum size starter shall be Size 1.
 - 1. All starters shall have the following:
 - a. Cover mounted hand-off-automatic switch. Starters installed exposed in occupied spaces shall have key operated HOA switch.
 - b. Ambient compensated thermal overload.
 - c. Fused control transformer (for 120 or 24 volt service).
 - d. Pilot lights, integral with the starters. Starters located outdoors shall be in NEMA IIIIR enclosures.
 - 2. Where three phase motors are provided for two-speed operation, provide two speed motor starters.

3. Starters for single-phase motors shall have thermal overloads. NEMA I enclosure for starters located indoors, NEMA IIIIR enclosure for starters located outdoors.
4. Provide OSHA label indicating the device starts automatically.

2.5 STRAINERS FOR POTABLE WATER SYSTEMS

- A. Strainers: Full line size, conforming to lead-free requirements of California Health and safety Code Section 11 68 75. "Y" pattern, 125 psi SWP minimum, with 304 stainless steel screens. Install all strainers with a blow-off hose valve with hose adapter. Strainer shall have gasketed cover with straight thread.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - a. 3 inches and smaller: bronze or brass body, threaded ends, with 20 mesh screen. Watts LF777SI, Wilkins SXL.
 - b. 4 inches and larger: Cast iron body, flanged ends, 1/16 inch or 1/8 inch screen as normally supplied for each size. Watts 77F-DI-125, Mueller 758.

2.6 VALVE BOXES

- A. General:
 1. Where several valves or other equipment are grouped together, provide larger boxes of rectangular "vault" type adequately sized for condition and similar in construction to those specified above.
 2. Provide valve box extensions as required to set bottom of valve box tight up to top of piping in which valve is installed.
 3. Provide a tee handle wrench for each size, Alhambra Foundry Co. #A-3008, or equal.
- B. Valve Boxes in Traffic Areas: Provide Christy No. G5 traffic valve box, Brooks, or equal, 10-3/8 inches inside diameter with extensions to suit conditions, with cast iron or steel locking cover. Provide Owner with set of special wrenches or tools as required for operation of valves.
- C. Valve Boxes in Non-Traffic Areas: Provide Christy No. F22, Brooks, or equal, 8 inches inside diameter by 30 inches long, with cast iron or steel locking cover. Provide Owner with set of special wrenches or tools as required for operation of valves. Cut bottom of plastic body for operation of valves.
- D. Valve Box (Rectangular Vault Type): Precast concrete or cast iron with cast iron or steel locking type covers lettered to suit service – Brooks No. 3-TL, Christy No. B3, Fraser No. 3, Alhambra A-3004 or A-3005, Alhambra E-2202, or E-2702, or equal, with extension to suit conditions.

2.7 GAUGES

- A. Marsh "Series J", U.S. Gage, Danton 800, or equal, with bronze bushed movement and front recalibration. Dials shall be white with black numerals, 3-1/2 inch dial face. Normal reading shall be at mid-scale. Provide a needle valve on each gauge connection. Supply a gauge piped with branch isolation valves across the inlet and outlet of each pump and where shown on the Drawings.
- B. Provide Pete's Plug II, Sisco P/T, or equal, test plug with Nordel core {and gasketed cap}, on inlet and outlet of each coil, boiler, condenser, chiller and heat exchanger and where shown on Drawings.

2.8 THERMOMETERS

- A. Marsh, Taylor, Palmer, or equal, 5 inch diameter bimetal dial, adjustable from face, with adjustable positioner, located to be easily read from normal personnel approach. Normal reading shall be at mid-scale.
 - 1. Provide extension for insulation.
 - 2. Provide thermometers with steel bulb chambers and brass separable sockets.
- B. Provide Pete's Plug II, Sisco P/T, or equal, test plug with Nordel core, on inlet and outlet of each coil, boiler, and heat exchanger and provide two digital electronic test thermometers for each range of fluid temperature and where shown on Drawings.

2.9 ACCESS DOORS

- A. Where floors, walls, or ceilings must be penetrated for access to mechanical equipment, provide access doors, 14 inch by 14 inch minimum size in usable opening. Where entrance of a serviceman may be required, provide 20 inch by 30 inch minimum usable opening. Locate access doors/panels for non-obstructed and easy reach.
 - 1. All access doors less than 7'-0" above floors and exposed to public access shall have keyed locks.
- B. Access doors shall match those supplied in Division 08 in all respects, except as noted herein.
- C. Provide stainless steel access doors for use in toilet rooms, shower rooms, kitchens and other damp areas. Provide steel access doors with prime coat of baked-on paint for all other areas.
- D. Do not locate access doors in highly visible public areas such as lobbies, waiting areas, and primary entrance areas. Coordinate with the Architect when access is required in these areas.
- E. Where specific information or details relating to access panels different from the above is shown or given on the Drawings or other Divisions of work, then that information shall supersede this specification.
- F. Manufacturers: Subject to compliance with requirements, available manufacturers offering products which may be incorporated into the Work include Milcor, Karp, Nystrom, or Cesco, equal to the following:
 - 1. Milcor
 - a. Style K (plaster).
 - b. Style DW (gypsum board).
 - c. Style M (Masonry).
 - d. Style "Fire Rated" where required.

2.10 EXPANSION LOOPS

- A. Manufactured assembly consisting of inlet and outlet elbow fittings, two sections of flexible metal hose and braid, and 180-degree return bend or center section of flexible hose. Flexible hose shall consist of corrugated metal inner hose and braided outer sheath. Provide assembly selected for 4 inches of movement.
- B. Provide CSA certified expansion loops listed for 4 inches of movement for use in natural or propane gas piping systems.

- C. Where used in potable water systems, provide expansion loops of certified lead-free construction.
- D. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - 1. Metraflex Inc., Metraloop series.
 - 2. Unisource Manufacturing, Inc., V series.

2.11 FLEXIBLE JOINTS

- A. Where indicated on Drawings, provide Metraflex Metrasphere, Style R, Mason Industries, or equal, Spherical Expansion Joints. Provide control units at each expansion joint, arranged to limit both expansion and compression.
- B. Flexible joints at entry points to building shall be Barco Ductile iron, Advanced Thermal Systems, or equal, threaded style with stainless ball and mineral filled seal.

2.12 PIPE GUIDES

- A. Where flexible connections are indicated on Drawings, provide Metraflex style IV, B-Line, or equal, pipe guides in locations recommended by manufacturer. Maximum spacing from flexible connection to first pipe guide is 4 pipe diameters, and maximum spacing from second pipe guide is 14 pipe diameters.

2.13 EQUIPMENT IDENTIFICATION

- A. Identify each piece of equipment with a permanently attached engraved bakelite plate, 1/2 inch high white letters on black background.

2.14 PIPE IDENTIFICATION

- A. Identify each piping system and indicate the direction of flow by means of Seton, Inc., Marking Services Inc., Reef Industries, Inc., or equal, pre-tensioned, coiled semi-rigid plastic pipe labels formed to circumference of pipe, requiring no fasteners or adhesive for attachment to pipe.
- B. The legends and flow arrows shall conform to ASME A13.1.

2.15 INSULATION WORK

- A. General:
 - 1. Insulation products, including insulation, insulation facings, jackets, adhesives, sealants and coatings shall not contain polybrominated diphenyl ethers (PBDEs) in penta, octa, or deca formulations in amounts greater than 0.1 percent (by mass).
 - 2. Adhesives and sealants shall comply with testing and product requirements of South Coast Air Quality Management District, Rule 1168.
 - 3. The term "piping" used herein includes pipe, valves, strainers and fittings.
 - 4. Apply insulating cement to fittings, valves and strainers and trowel smooth to the thickness of adjacent covering. Cover with jacket to match piping. Extend covering on valves up to the bonnet. Leave strainer cleanout plugs accessible.
 - 5. Provide pre-formed PVC valve and fitting covers.
 - 6. Provide Calcium Silicate rigid insulation and sheet metal sleeve, 18 inch minimum length at each pipe hanger. Seal ends of insulation to make vapor tight with jacket.

7. Test insulation, jackets and lap-seal adhesives as a composite product and confirm flame spread of not more than 25 and a smoke developed rating of not more than 50 when tested in accordance with UL723 or ASTM E84.
 8. Clean thoroughly, test and have approved, all piping and equipment before installing insulation and/or covering.
 9. Repair all damage to existing pipe and equipment insulation whether or not caused during the work of this contract, to match existing adjacent insulation for thickness and finish, but conforming to flame spread and smoke ratings specified above.
- B. Insulation of Piping:
1. Insulate domestic hot and tempered water with minimum 3-1/2 pounds per cubic foot density fiberglass with ASJ-SSL jacket. Insulation thickness shall be the following:
 - a. Pipe 3/4 inches and smaller: 1 inch thick.
 - b. Pipe 1 inch through 1-1/2 inches: 1-1/2 inches thick.
 - c. Pipe 2 inches and larger: 2 inches thick.
 2. Insulate roof drain and overflow drain bodies, horizontal sections of rainwater leader piping and overflow piping, and condensate drains within the building envelope with 1 inch thick fiberglass, minimum 3-1/2 pound per cubic foot density, with ASJ-SSL jacket.
 3. Exposed insulated piping within the building shall have a Zeston 2000 25/50, Proto Lo-Smoke, or equal, PVC jacket and fitting cover installed over the insulation, applied per manufacturer's instructions. Insulation shall be vapor tight before applying PVC jacket and fitting covers. Verify suitability with manufacturer of insulation. Insulation with pre-applied polymer jacket may be substituted at Contractor's option.
 4. Insulate condensate drain piping in freezer with 3/4 inch thick Therma-Cel, Armaflex, or equal. Seal water tight per manufacturer's directions. Install heat tape prior to insulation of piping, in accordance with manufacturer's directions.
 5. Where insulated piping is exposed to the weather apply aluminum jacket secured with 1/2 inch stainless-steel bands on 12 inch centers. Insulation shall be vapor tight before applying metal jacket, and aluminum fitting covers. Install jacketing with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Cover fittings with glass cloth, two coats of Foster Sealfas 30-36, and factory-fabricated aluminum fitting covers, of same material, finish, and thickness as jacket. Insulation shall be vapor tight before applying metal jacket and fitting covers.
 - a. Fitting covers:
 - 1) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - 2) Tee covers.
 - 3) Flange and union covers.
 - 4) End caps.
 - 5) Beveled collars.
 - 6) Valve covers.
 - 7) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
 - b. Jacket thickness:
 - 1) Pipes 10 inches diameter and smaller: Minimum .016 inch thick jacket with smooth finish.
 - 2) Pipes 12 inches diameter and larger: Minimum .020 inch thick jacket with smooth finish.

PART 3 - EXECUTION

3.1 FRAMING, CUTTING AND PATCHING

- A. Special framing, recesses, chases and backing for Work of this Section, unless otherwise specified, are covered under other Specification Sections.
- B. Contractor is responsible for placement of pipe sleeves, hangers, inserts, supports, and location of openings for the Work.

3.2 ELECTRICAL REQUIREMENTS

- A. Provide adequate working space around electrical equipment in compliance with the California Electrical Code. Coordinate the Mechanical Work with the Electrical Work to comply.
- B. Furnish necessary control diagrams and instructions for the controls. Before permitting operation of any equipment which is furnished, installed, or modified under this Section, review all associated electrical work, including overload protection devices, and assume complete responsibility for the correctness of the electrical connections and protective devices. Motors and control equipment shall conform to the Standards of the National Electrical Manufacturers' Association. All equipment and connections exposed to the weather shall be NEMA IIIR with factory-wired strip heaters in each starter enclosure and temperature control panel where required to inhibit condensation.
- C. All line voltage and low voltage wiring and conduit associated with the Temperature Control System are included in this Section. Wiring and conduit shall comply with Division 26.

3.3 PIPING SYSTEM REQUIREMENTS

- A. Drawing plans, schematic and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

3.4 PRIMING AND PAINTING

- A. Perform priming and painting on the equipment and materials as specified herein.
- B. See Division 09 Painting Section(s) for detailed requirements.
- C. Priming and Painting:
 - 1. Exposed ferrous metals, including piping, which are not galvanized or factory-finished shall be primed and painted.
 - a. Black Steel Piping:
 - 1) Primer: One coat gray Sherwin-Williams Pro Industrial Pro-Cryl Universal Primer, comparable products by Rust-Oleum, Kelly Moore, or equal.
 - 2) Topcoat: Two coats gray Sherwin-Williams Pro Industrial Waterbased Alkyd Urethane Enamel, comparable products by Rust-Oleum, Kelly Moore, or equal.

2. Metal surfaces of items to be jacketed or insulated except piping shall be given two coats of primer unless furnished with equivalent factory finish. Items to be primed shall be properly cleaned by effective means free of rust, dirt, scale, grease and other deleterious matter and then primed with the best available grade of zinc rich primer. After erection or installation, all primed surfaces shall be properly cleaned of any foreign or deleterious matter that might impair proper bonding of subsequent paint coatings. Any abrasion or other damage to the shop or field prime coat shall be properly repaired and touched up with the same material used for the original priming.
3. Where equipment is provided with nameplate data, the nameplate shall be masked off prior to painting. When painting is completed, remove masking material.

3.5 EXCAVATING

- A. Perform all excavating required for work of this Section. Provide the services of a pipe/cable locating service prior to excavating activities to determine location of existing utilities.
- B. Unless shown otherwise, provide a minimum of 2'-6" cover above top of pipe to finished grade for all service piping, unless otherwise noted. Trim trench bottom by hand or provide a 4 inch deep minimum bed of sand to provide a uniform grade and firm support throughout entire length of pipe. For all PVC pipe and for PE gas pipe, bed the pipe in 4 inch sand bed. Pipe bedding materials should be clean crushed rock, gravel or sand of which 100 percent will pass a 1 inch sieve. For pipes that are larger than 10 inches in diameter, at least 95 percent should pass a 3/4 inch sieve, and for pipes 10 inches in diameter or smaller, 100 percent should pass a 1/2 inch sieve. All other materials should have a minimum sand equivalent of 50. Only a small proportion of the native soils will meet these requirements without extensive processing; therefore, importation of pipe bedding materials should be anticipated. Pipe bedding materials shall be compacted in lifts not exceeding 6 inches in compacted thickness. Each lift shall be compacted to not less than 90 percent relative compaction at or above the optimum moisture content, in accordance with ASTM Specification D2940, except that bedding materials graded such that 100 percent of the material will pass a No. 200 sieve shall be compacted in 6 inch lifts using a single pass of a flat-plate, vibratory compactor or vibratory drum. Pipe bedding materials should extend at least to the spring line.
- C. Maintain all warning signs, barricades, flares, and red lanterns as required.
- D. For all trenches 5 feet or more in depth, submit copy of permit detailed drawings showing shoring, bracing, sloping, or other provisions to be made for worker protection from the hazard of caving ground during the excavation of such trenches. Obtain a permit from the Division of Industrial Safety prior to beginning excavations. A copy of the permit shall be available at the site at all times.

3.6 BACKFILLING

- A. Backfill shall comply with applicable provisions of Division 31 of these Specifications.
- B. Except under existing or proposed paved areas, walks, roads, or similar surfaces, backfill for other types of pipe shall be made using suitable excavated material or other approved material. Place backfill in 8 inch layers, measured before compaction, and compact with impact hammer to at least 90 percent relative compaction per ASTM D2940.
 1. Backfill plastic pipe and insulated pipe with sand for a minimum distance of 12 inches above the top of the pipe. Compact using mechanical tamping equipment.

- C. Entire backfill for excavations under existing or proposed pavements, walks, roads, or similar surfaces, under new slabs on grade, shall be made with clean sand compacted with mechanical tamping equipment vibrator to at least 90 percent relative compaction per ASTM D2940. Remove excess earth. Increase the minimum compaction within the uppermost two feet of backfill to 95 percent.
- D. Replace or repair to its original condition all sod, concrete, asphalt paving, or other materials disturbed by the trenching operation. Repair within the guarantee period as required.

3.7 PIPING SYSTEMS INSTALLATION

- A. At time of final connection, and prior to opening valve to allow pressurization of water and gas piping from existing systems, on site or off site, perform a pressure test to indicate static pressure of existing systems. If pressure on water piping is greater than 80 psi, or gas pressure is not as indicated on Contract Documents, inform Architect immediately. Do not allow piping systems to be pressurized without written consent of the Architect.
- B. General:
 - 1. All piping shall be concealed unless shown or otherwise directed. Allow sufficient space for ceiling panel removal.
 - 2. Installation of piping shall be made with appropriate fittings. Bending of piping will not be accepted.
 - 3. Install piping to permit application of insulation and to allow valve servicing.
 - 4. Where piping or conduit is left exposed within a room, the same shall be run true to plumb, horizontal, or intended planes. Where possible, uniform margins are to be maintained between parallel lines and/or adjacent wall, floor, or ceiling surfaces.
 - 5. Horizontal runs of pipes and/or electrical conduit suspended from ceilings shall provide for a maximum headroom clearance. The clearance shall not be less than 6'-6" without written approval from the Architect.
 - 6. Close ends of pipe immediately after installation. Leave closure in place until removal is necessary for completion of installation.
 - 7. Each piping system shall be thoroughly flushed and proved clean before connection to equipment.
 - 8. Pipe the discharge of each relief valve, air vent, backflow preventer, and similar device to floor sink or drain.
 - 9. Install exposed polished or enameled connections with special care showing no tool marks or threads at fittings.
 - 10. Install horizontal valves with valve stem above horizontal.
 - 11. Use reducing fittings; bushings shall not be allowed. Use eccentric reducing fittings wherever necessary to provide free drainage of lines and passage of air.
 - 12. Verify final equipment locations for roughing-in.
 - 13. Service Markers: Mark the location of each plugged or capped pipe with a 4 inch round by 30 inch long concrete marker, set flush with finish grade. Provide 2-1/2 inch diameter engraved brass plate as part of monument marker.
 - 14. Furnish and install anchors or thrust blocks on PVC water lines in the ground, at all changes in direction of piping, and at all connections or branches from mains 1-1/2 inch and larger. Form anchors or thrust blocks by pouring concrete between pipe and trench wall. Thrust blocks shall be of adequate size and so placed as to take thrusts created by maximum internal water pressure. Sizing and placement shall be per manufacturer's recommendations, CPC, and IAPMO installation standards. Anchor piping to building construction.

15. Sanitary Sewer and Storm Drain: Grade piping inside building uniformly 1/4 inch per foot if possible but not less than 1/8 inch per foot. Run piping as straight as possible. Make piping connections between building piping and outside service pipe with cast iron reducers or increasers. Slope sewers uniformly between given elevations where invert elevations are shown.
 16. Where piping is installed in walls within one inch of the face of stud, provide a 16 gauge sheet metal shield plate on the face of the stud. The shield plate shall extend a minimum of 1-1/2 inches beyond the outside diameter of the pipe.
- C. Expansion Loops:
1. Install expansion loops where piping crosses building expansion or seismic joints, between buildings, between buildings and canopies, and as indicated on Drawings.
 2. Install expansion loops of sizes matching sizes of connected piping.
 3. Install grooved-joint expansion joints to grooved-end steel piping.
 4. Materials of construction and end fitting type shall be consistent with pipe material and type of gas or liquid conveyed by the piping system in which expansion loop is installed.
- D. Sleeves:
1. Install Adjus-to-Crete, Pipeline Seal and Insulator, or equal, pipe sleeves of sufficient size to allow for free motion of pipe, 24 gauge galvanized steel. The space between pipe and sleeves through floor slabs on ground, through outside walls above or below grade, through roof, and other locations as directed shall be caulked with oakum and mastic and made watertight. The space between pipe and sleeve and between sleeve and slab or wall shall be sealed watertight.
 2. At Contractor's option, Link-Seal, Metraflex Metraseal, or equal, casing seals may be used in lieu of caulking. Wrap pipes through slabs on grade with 1 inch thick fiberglass insulation to completely isolate the pipe from the concrete.
- E. Floor, Wall, and Ceiling Plates:
1. Fit all pipes with or without insulation passing through walls, floors, or ceilings, and all hanger rods penetrating finished ceilings with chrome-plated or stainless escutcheon plates.
- F. Firestopping:
1. Pack the annular space between the pipe sleeves and the pipe through all floors and walls with UL listed fire stop, and sealed at the ends. All pipe penetrations shall be UL listed, Hilti, 3M Pro-Set, or equal.
 - a. Install fire caulking behind mechanical services installed within fire rated walls, to maintain continuous rating of wall construction.
 2. Provide SpecSeal Systems UL fire rated sleeve/coupling penetrators for each pipe penetration or fixture opening passing through floors, walls, partitions or floor/ceiling assemblies. All Penetrators shall comply with UL Fire Resistance Directory (Latest Edition), and in accordance with Chapter 7, CBC requirements.
 3. Sleeve penetrators shall have a built in anchor ring for waterproofing and anchoring into concrete pours or use the special fit cored hole penetrator for cored holes.
 4. Copper and steel piping shall have SpecSeal plugs on both sides of the penetrator to reduce noise and to provide waterproofing.
 5. All above Systems to be installed in strict accordance with manufacturer's instructions.
 6. Alternate firestopping systems are acceptable if approved equal. However, any deviation from the above specification requires the Contractor to be responsible for determining the suitability of the proposed products and their intended use, and the Contractor shall assume all risks and liabilities whatsoever in connection therewith.
- G. Flashing:

1. Flashing for penetrations of metal or membrane roof for mechanical items such as flues and pipes shall be coordinated with the roofing manufacturer and roofing installer for the specific roofing type. The work of this section shall include furnishing, layout, sizing, and coordination of penetrations required for the mechanical work.
 - a. Furnish and install flashing and counterflashing in strict conformance with the requirements of the roofing manufacturer. Submit shop drawing details for review prior to installation.
 - b. Furnish and install counterflashing above each flashing required. Provide Stoneman, or equal, vandalproof top and flashing combination. Provide vandalproof top for each plumbing vent through roof. Elmdor/Stoneman Model 1540, 1550, 1570, or equal.
 2. For all other types of roofing system, furnish and install around each pipe, where it passes through roof, a flashing and counterflashing. All flashing shall be made of four pound seamless sheet lead with 6 inch minimum skirt and steel reinforced boot. Counterflashing shall be cast iron. For vents, provide vandalproof top and flashing combination. Elmdor/Stoneman Model 1100-4, 1100-5, 1100-7, or equal.
- H. Hangers and Supports:
1. General: Support equipment and piping so that it is firmly held in place by approved iron hangers and supports and special hangers. Hanger and support components shall support weight of equipment and pipe, fluid, and pipe insulation based on spacing between supports with minimum factor of safety of five based on ultimate strength of material used. Do not exceed manufacturer's load rating. Pipe attachments or hangers, of same size as pipe or tubing on which used, or nearest available. Rigidly fasten hose faucets, fixture stops, compressed air outlets, and similar items to the building construction. The Architect shall approve hanger material before installation. Do not support piping with plumbers' tape, wire rope, wood, or other makeshift devices. Where building structural members do not match piping support spacing, provide "bridging" support members firmly attached to building structural members in a fashion approved by the structural engineer.
 - a. Materials, design, and type numbers per Manufacturers' Standardization Society (MSS), Standard Practice (SP)-58.
 - 1) Provide copper-plated or felt-lined hangers for use on copper tubing.
 2. Hanger components shall be provided by one manufacturer: B-Line, Grinnell, Unistrut, Badger, or equal.
 3. Riser clamps: B-line model B3373, or equal.
 4. Pipe Hanger and Support Placement and Spacing:
 - a. Vertical piping support spacing: Provide riser clamps for piping, above each floor, in contact with the floor. Provide support at joints, branches, and horizontal offsets. Provide additional support for vertical piping, spaced at or within the following maximum limits:

<u>Pipe Diameter</u>	<u>Steel Threaded or Welded (Note 3)</u>	<u>Steel Gas</u>	<u>Copper Brazed or Soldered (Note 3)</u>	<u>CPVC & PVC (Note 2)</u>
1/2 - 1"	12 ft.	6 ft.	Each Floor, Not to Exceed 10 ft.	Base and Each Floor (Note 1)
1-1/4 - 2"	12 ft.	Each Floor, Not to Exceed 10 ft.	Each Floor, Not to Exceed 10 ft..	Base and Each Floor (Note 1)
2-1/2 - 3"	12 ft.	Each Floor, Not to Exceed 10 ft.	Each Floor, Not to Exceed 10 ft.	Base and Each Floor (Note 1)
Over 4"	12 ft.	Each Floor, Not to Exceed 10 ft.	Each Floor, Not to Exceed 10 ft.	Base and Each Floor (Note 1)

- 1) Note 1: Provide mid-story guides.
 - 2) Note 2: For PVC piping, provide for expansion every 30 feet per IAPMO installation standard. For CPVC piping, provide for expansion per IAPMO installation standard.
 - 3) Note 3: Spacing of hangers and supports for piping assembled with mechanical joints shall be in accordance with standards acceptable to authorities having jurisdiction.
- b. Vertical cast iron piping support spacing: Base and each floor not to exceed 15 feet.
 - c. Horizontal piping, hanger and support spacing: Locate hangers and supports at each change of direction, within one foot of elbow, and spaced at or within following maximum limits:

<u>Pipe Diameter</u>	<u>Steel Threaded or Welded (Note 2)</u>	<u>Steel Gas</u>	<u>Copper Brazed or Soldered (Notes 2, 3)</u>	<u>CPVC & PVC (Note 1)</u>
1/2 - 1"	6 ft.	6 ft.	5 ft.	3 ft.
1-1/4 - 2"	7 ft.	10 ft.	6 ft.	4 ft.
2-1/2 - 3"	10 ft.	10 ft.	10 ft.	4 ft.
Over 4"	10 ft.	10 ft.	10 ft.	4 ft.

- 1) Note 1: For PVC piping, provide for expansion every 30 feet per IAPMO installation standard. For CPVC piping, provide for expansion per IAPMO installation standard.

- 2) Note 2: Spacing of hangers and supports for piping assembled with mechanical joints shall be in accordance with standards acceptable to authorities having jurisdiction.
- 3) Note 3: Includes all refrigerant piping, including vapor and hot gas pipes.
- d. Horizontal cast iron piping support spacing:
 - 1) Support piping at every other joint for piping length of less than 4 feet.
 - 2) For piping longer than 4 feet, provide support on each side of the coupling, within 18 inches of each joint.
 - 3) Hanger shall not be installed on the coupling.
 - 4) Provide support at each horizontal branch connection.
 - 5) Provide sway brace at 40 foot maximum spacing for suspended pipe with no-hub joints, except where a lesser spacing is required by the seismic design criteria used in delegated design for seismic systems. Refer to Article, Submittals.
 - 6) Provide a brace on each side of a change in direction of 90 degrees or more.
- 5. Suspended Piping:
 - a. Individually suspended piping: B-Line B3690 J-Hanger or B3100 Clevis, complete with threaded rod, or equal. All hangers on supply and return piping handling heating hot water or steam shall have a swing connector at point of support.

<u>Pipe Size</u>	<u>Rod Size Diameter</u>
2" and Smaller	3/8"
2-1/2" to 3-1/2"	1/2"
4" to 5"	5/8"
6"	3/4"

- b. Provide 3/8 inch rod for support of PVC and CPVC and provide continuous support.
- c. Trapeze Suspension: B-Line 1-5/8 inch width channel in accordance with manufacturer's published load ratings. No deflection to exceed 1/180 of a span.
- d. Trapeze Supporting Rods: Shall have a safety factor of five; securely anchor to building structure.
- e. Pipe Clamps and Straps: B-Line B2000, B2400; isolate copper pipe with two thicknesses of 2 inches wide 10-mil polyvinyl tape. Where used for seismic support systems, provide B-Line B2400 series pipe straps.
- f. Concrete Inserts: B-line B22-I continuous insert or B2500 spot insert. Do not use actuated fasteners for support of overhead piping unless approved by Architect.
- g. Steel Connectors: Beam clamps with retainers.
- 6. Support to Structure:
 - a. Steel Structure: Provide and install additional steel bracing as required to suit structure. Provide through bolts with length to suit requirements of the structural components. Burning or welding on any structural member may only be done if approved by the Architect.
- 7. Rubber Neoprene Pipe Isolators:
 - a. Pipe isolators shall comprise an internal rubber or neoprene material that isolates pipe from hanger and structure. Install at all piping located in acoustical walls. Refer to Architectural Drawings for location of acoustical walls.
 - b. Isolation material shall be either a rubber or neoprene material that prevents contact between the pipe and the structure. The rubber shall have between a 45 to 55 durometer rating and a minimum thickness of 1/2 inch.

- c. Acceptable Suppliers:
 - 1) Vertical runs: Acousto-Plumb or equal.
 - 2) Horizontal runs: B-Line, Vibraclamp; Acousto-Plumb or equal.
- 8. Provide support for piping through roof, arranged to anchor piping solidly in place at the roof penetration.
- 9. Provide rigid insulation and a 12 inch long, 18 gauge galvanized sheet iron shield between the covering and the hanger whenever hangers are installed on the outside of the pipe covering.
- 10. Insulate copper tubing from ferrous materials and hangers with two thicknesses of 3 inch wide, 10 mil polyvinyl tape wrapped around pipe.
- 11. Provide a support or hanger close to each change of direction of pipe either horizontal or vertical and as near as possible to concentrated loads.
- 12. Suspend rods from concrete inserts with removable nuts where suspended from concrete decks. Power actuated inserts will not be allowed.

3.8 UNION AND FLANGE INSTALLATION

- A. Install Watts, Epco, Nibco, or equal, dielectric unions or flanges at points of connection between copper or brass piping or material and steel or cast iron pipe or material except in drain, waste, vent, or rainwater piping. Bushings or couplings shall not be used. Dielectric unions installed in potable water systems shall conform to the lead-free requirements of the California Health and Safety Code Section 11 68 75.
- B. Install unions in piping NPS 2" and smaller, and flanges in piping NPS 2-1/2" and larger whether shown or not at each connection to all equipment and tanks, and at all connections to all automatic valves, such as temperature control valves. Unions installed in potable water systems shall conform to the lead-free requirements of the California Health and Safety Code Section 11 68 75.
- C. Locate the unions for easy removal of the equipment, tank, or valve.

3.9 ACCESS DOOR INSTALLATION

- A. Furnish and install access doors wherever required whether shown or not for easy maintenance of mechanical systems; for example, at concealed valves, strainers, traps, cleanouts, dampers, motors, controls, operating equipment, etc. Access doors shall provide for complete removal and replacement of equipment.

3.10 CONCRETE WORK

- A. Concrete work required for work of this Section shall be included under another section of the Specification, unless otherwise noted, including poured-in-place concrete work for installing precast manholes, catch basins, etc., and shall include reinforced concrete bases for pumps, tanks, compressors, fan units, boilers, unless the work is specifically indicated on the Drawings to be furnished under this Section.
- B. Thrust blocks, underground anchors, and pads for cleanouts, valve access boxes and washer boxes are included under this Section of the Specification. Concrete shall be 3000 psi test minimum. Refer to Division 03 for concrete types.

3.11 PIPE PROTECTION

- A. Sleeve copper piping/tubing installed below slab with "Polywrap-C" polyethylene sleeve, as manufactured by Northtown Pipe Protection Products, or equal. Sleeve shall be a minimum of 6 mils thick, colored blue for domestic water piping and orange for other piping. Install sleeve per manufacturer's recommendations and instructions.
- B. Sleeve copper piping/tubing installed outside building below grade with "Polywrap-C" polyethylene sleeve, as manufactured by Northtown Pipe Protection Products, or equal. Sleeve shall be a minimum of 6 mils thick, colored blue for domestic water piping. Install sleeve per manufacturer's recommendations and instructions.
- C. Sleeve cast iron and ductile iron pipe below grade and below slab with "Polywrap" polyethylene sleeve, as manufactured by Northtown Pipe Protection Products, or equal. Sleeve shall be a minimum of 8 mils thick, colored natural. Install sleeve per manufacturer's recommendations and instructions.
- D. Covering: No rocks or sharp edges shall be backfilled against the wrap or sleeve. When backfilling with other than sand, protect wrap with an outer wrapping of Kraft paper; leave in place during backfill.

3.12 PIPE IDENTIFICATION

- A. Provide temporary identification of each pipe installed, at the time of installation. Temporary identification shall be removed and replaced with permanent identification as part of the work.
- B. Apply the legend and flow arrow at all valve locations; at all points where the piping enters or leaves a wall, partition, cluster of piping or similar obstruction, at each change of direction and at approximately 20'-0" intervals on pipe runs. Variations or changes in locations and spacing may be made with the approval of the Architect. There shall be at least one marking in each room. Markings shall be located for maximum visibility from expected personnel approach.
 - 1. Apply legend and flow arrow at approximately 10'-0" intervals in science classrooms and science prep rooms.
- C. Wherever two or more pipes run parallel, the markings shall be supplied in the same relative location on each.
- D. Each valve on non-potable water piping shall be labeled with a metal tag stamped "DANGER -- NON-POTABLE WATER" in 1/4 inch high letters.
- E. Apply markings after painting and cleaning of piping and insulation is completed.

3.13 EXPANSION ANCHORS IN HARDENED CONCRETE

- A. Refer to Structural Drawings.

3.14 PIPING SYSTEM PRESSURE TESTING

- A. General:
 - 1. Perform operational tests under simulated or actual service conditions, including one test of complete plumbing installation with fixtures and other appliances connected.

2. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
- B. Piping Systems: Test piping systems in accordance with the following requirements and applicable codes:
1. Authority having jurisdiction shall witness tests of piping systems.
 2. Notify Architect at least seven days in advance of testing.
 3. All piping shall be tested at completion of roughing-in, or at other times as directed by Architect.
 4. Furnish necessary materials, test pumps, gases, instruments and labor required for testing.
 5. Isolate from system equipment that may be damaged by test pressure.
- C. Test Schedule: No loss in pressure or visible leaks shall show after four hours at the pressures indicated.
- D. Testing of Sanitary Sewer, Drain, Vent, and Storm Drain may be done in segments in order to limit pressure to within manufacturer’s recommendations. Test to 10 feet above highest point in the system.

<u>System Tested</u>	<u>Test Pressure PSI</u>	<u>Test With</u>
Sanitary Sewer, Drain, Vent	10 Ft. Hd.	Water
Storm Drain, Condensate Drains	10 Ft. Hd.	Water
Domestic Water	125	Water
Natural Gas (PE)	60	Air & Non-corrosive Leak Test Fluid
Natural Gas (Steel)	100	Air & Non-corrosive Leak Test Fluid
Compressed Air	200 lb.	Air & Non-corrosive Leak Test Fluid
Deionized Water	50	Water

1. Flush deionized water lines with deionized water after test and approval.
2. Non-corrosive leak test fluid shall be suitable for use with piping material specified, and with the type of gas conveyed by the piping system.

3.15 OPERATION OF SYSTEMS

- A. Do not operate any plumbing equipment for any purpose, temporary or permanent, until all of the following has been completed:
1. Complete all requirements listed under “Check, Test and Start Requirements.”
 2. Piping has been properly cleaned. Piping systems shall be flushed and treated prior to operation.
 3. Filters, strainers etc. are in place.
 4. Bearings have been lubricated, and alignment of rotating equipment has been checked.

5. Equipment has been run under observation, and is operating in a satisfactory manner.
- B. Provide test and balance agency with one set of Contract Drawings, Specifications, Addenda, Change orders issued, applicable shop drawings and submittals and temperature control drawings.

3.16 CHECK, TEST AND START REQUIREMENTS

- A. An authorized representative of the equipment manufacturer shall perform check, test and start of each piece of plumbing equipment. The representative may be an employee of the equipment manufacturer, or a manufacturer-certified contractor. Submit written certification from the manufacturer stating that the representative is qualified to perform the check test and start of the equipment.
1. As part of the submittal process, provide a copy of each manufacturer's printed startup form to be used.
 2. Some items of specified equipment may require that check, test and start of equipment must be performed by the manufacturer, using manufacturer's employees. See specific equipment Articles in these Specifications for this requirement.
 3. Provide all personnel, test instruments, and equipment to properly perform the check, test and start work.
 4. When work has been completed, provide copies of reports for review, prior to final observation of work.
- B. Provide copies of the completed check, test and start report of each item of equipment, bound with the Operation and Maintenance Manual.
- C. Upon completion of the work, provide a schedule of planned maintenance for each piece of equipment. Indicate frequency of service, recommended spare parts (including filters and lubricants), and methods for adjustment and alignment of all equipment components. Provide a copy of the schedule with each operating and maintenance manual. Provide a copy of certification from the Owner's representative indicating that they have been properly instructed in maintenance requirements for the equipment installed.

3.17 PRELIMINARY OPERATIONAL REQUIREMENTS AND TESTS

- A. Prior to observation to determine final acceptance, put all mechanical systems into service and check that work required for that purpose has been done, including but not limited to the following condensed check list. Provide indexed report to tabulating the results of all work.
1. All equipment has been started, checked, lubricated and adjusted in accordance with the manufacturer's recommendations.
 2. Correct rotation of motors and ratings of overload heaters are verified.
 3. Specified filters are installed and spare filters have been turned over to Owner.
 4. All manufacturers' certificates of start-up specified have been delivered to the Owner.
 5. All equipment has been cleaned, and damaged painted finishes touched up.
 6. Missing or damaged parts have been replaced.
 7. Flushing and chemical treatment of piping systems has been completed and water treatment equipment, where specified, is in operation.
 8. Equipment labels, pipe marker labels, ceiling markers and valve tags are installed.
 9. Valve tag schedules, corrected control diagrams, sequence of operation lists and start-stop instructions have been posted.
 10. Preliminary test and balance work is complete, and reports have been forwarded for review.
 11. Automatic control set points are as designated and performance of controls checks out to agree with the sequence of operation.

12. Operation and Maintenance Manuals have been delivered and instructions to the operating personnel have been made.
- B. Prior to the observation to determine final acceptance, operate all mechanical systems as required to demonstrate that the installation and performance of these systems conform to the requirements of these specifications.
 1. Operate and test all mechanical equipment and systems for a period of at least five consecutive 8 hour days to demonstrate the satisfactory overall operation of the project as a complete unit.
 2. Commence tests after preliminary balancing and adjustments to equipment have been checked. Immediately before starting tests, install air filters and lubricate all running equipment. Notify the Architect at least seven calendar days in advance of starting the above tests.
 3. During the test period, make final adjustments and balancing of equipment, systems controls, and circuits so that all are placed in first class operating condition.
 4. Where Utility District rebates are applicable, demonstrate that the systems meet the rebate program requirements.
- C. Review of Contractor's Tests:
 1. All tests made by the Contractor or manufacturers' representatives are subject to observation and review by the Owner. Provide timely notice prior to start of each test, in order to allow for observation of testing. Upon the completion of all tests, provide a letter to confirm that all testing has been successful.
- D. Test Logs:
 1. Maintain test logs listing the tests on all mechanical systems showing dates, items tested, inspectors' names, remarks on success or failure of the tests.
- E. Preliminary Operation:
 1. The Owner reserves the right to operate portions of the plumbing system on a preliminary basis without voiding the guarantee.

3.18 CERTIFICATES OF INSTALLATION

- A. Contractor shall complete applicable "Certificates of Installation" forms contained in the California Building Energy Efficiency Standards and submit to the authorities having jurisdiction for approval and issuance of final occupancy permit, as described in the California Energy Code.

3.19 DEMONSTRATION AND TRAINING

- A. An authorized representative of the equipment manufacturer shall train Owner-designated personnel in maintenance and adjustment of equipment. The representative may be an employee of the equipment manufacturer, or a manufacturer-certified contractor. Submit written certification from the manufacturer stating that the representative is qualified to perform the Owner training for the equipment installed.
 1. As part of the submittal process, provide a training agenda outlining major topics and time allowed for each topic.
 2. Some items of specified equipment require that training must be performed by the manufacturer, using manufacturer's employees. See specific equipment Articles in these Specifications for this requirement.
 3. Contractor shall provide three copies of certification by Contractor that training has been completed, signed by Owner's representative, for inclusion in Operation and Maintenance Manual. Certificates shall include:
 - a. Listing of Owner-designated personnel completing training, by name and title.

- b. Name and title of training instructor.
 - c. Date(s) of training.
 - d. List of topics covered in training sessions.
4. Refer to specific equipment Articles for minimum training period duration for each piece of equipment.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Pipe and fittings.
 - 2. Valves.
 - 3. Domestic water piping specialties.
 - 4. Gas piping specialties.
 - 5. Drain and waste piping specialties.

1.2 RELATED REQUIREMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 22 00 50 Basic Plumbing Materials and Methods.

1.3 ACTION SUBMITTALS

- A. For additional requirements, refer to Section 22 00 50, Basic Plumbing Materials and Methods.
- B. Product Data: Submit manufacturer's technical product data and installation instructions for plumbing piping systems materials and products.

1.4 INFORMATIONAL SUBMITTALS

- A. For additional requirements, refer to Section 22 00 50, Basic Plumbing Materials and Methods.
- B. Provide welding certificate for all gas pipe welders.
- C. Gas Pipe Installer Qualifications: Provide evidence of current qualifications for individuals performing work requiring qualifications.

1.5 CLOSEOUT SUBMITTALS

- A. For additional requirements, refer to Section 22 00 50, Basic Plumbing Materials and Methods.
- B. Maintenance Data: Submit maintenance data and parts lists for plumbing piping systems materials and products. Include this data in Operation and Maintenance Manual.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish to Owner, with receipt, one valve key for each key operated hydrant, bibb, or faucet installed.

1.7 QUALITY ASSURANCE

- A. For additional requirements, refer to Section 22 00 50, Basic Plumbing Materials and Methods.

- B. Gas Pipe Installer Qualifications: Individuals performing tasks requiring qualifications under Federal and State regulations shall be qualified by the gas utility supplying Project site. The qualifications shall be current at the time of performing the Work.
- C. NFPA/ANSI Compliance: Fabricate and install natural gas systems in accordance with latest edition of NFPA 54/ANSI Z223.1 "National Fuel Gas Code."
- D. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- E. Fabricate and install natural gas systems in accordance with California Plumbing Code.
- F. Utility Compliance: Fabricate and install natural gas systems in accordance with local gas utility company requirements.

1.8 FIELD CONDITIONS

- A. Interruption of Existing Services: Do not interrupt services to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary services according to requirements indicated:
 - 1. Notify no fewer than two days in advance of proposed interruption of services.

PART 2 - PRODUCTS

2.1 MATERIALS AND PRODUCTS

- A. Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, temperature ratings, and capacities as indicated. Provide materials and products complying with California Plumbing Code. Where more than one type of material or product is indicated, selection from materials or products specified is Contractor's option.
- B. Potable-water piping and components shall comply with NSF 14, NSF 61, and NSF 372. Plastic piping components shall be marked with "NSF-pw."

2.2 PIPE AND FITTINGS ATTACHED TO AND BELOW BUILDINGS INCLUDING 5 FEET FROM BUILDINGS

- A. Piping and fittings attached to covered walkways and corridors shall comply with the requirements of this article.
- B. Drain and Waste Pipe Above Grade: Cast iron soil pipe and fittings, asphaltic coated, conforming to ASTM A888 and Cast Iron Soil Pipe Institute Standard (CISPI) 301 and so marked. Pipe and fittings shall be as manufactured by AB&I, Charlotte, Tyler Pipe, or equal. Pipe and fittings shall be the products of a single manufacturer. At Contractor's option, vertical piping above floor from lavatories, sinks, and drinking fountains may be Schedule 40 galvanized steel pipe with black cast iron drainage fittings, or DWV weld pipe and fittings.
 - 1. Joints above grade: No-Hub pipe conforming to ASTM A888 and CISPI 301. Couplings conforming to ASTM 1277 and CISPI 310, with stainless steel bands. Provide products by ANACO-Husky, Tyler, Ideal or equal. Provide sway brace at 20'-0" maximum spacing for suspended pipe with No-Hub joints. Provide a brace on each side of a change in direction of 90 degrees or more. Brace riser joints at each floor and at 15 foot maximum intervals (also see Specification Section 22 00 50).
 - a. Provide sway brace at each joint per 2016 CBC.

- b. Joints located over critical areas including food preparation, food storage, food serving, and eating areas shall be ANACO-Husky SD 4000, Clamp-All 125, or equal, meeting the requirements of FM 1680, SD Class I and ASTM C1540.
- C. Drain and Waste Pipe Below Grade: Cast iron soil pipe and fittings, asphaltic coated, conforming to ASTM A888 and CISPI 301 and so marked. Pipe and fittings shall be as manufactured by AB&I, Charlotte, Tyler Pipe, or equal. Pipe and fittings shall be the products of a single manufacturer. At Contractor's option, hub and spigot cast iron soil pipe and fittings, asphaltic coated, conforming to ASTM A-74 and so marked, may be used.
 - 1. Joints below grade: ANACO-Husky SD 4000, Clamp-All 125, or equal couplings and No-Hub fittings, meeting the requirements of FM 1680, SD Class I and ASTM C1540.
 - 2. Joints below grade (hub and spigot option): Neoprene gaskets conforming to ASTM C564, as manufactured by Ty-Seal, Dual-Tite, or equal.
- D. Vent Pipe:
 - 1. 3 inch and larger: Cast iron soil pipe and fittings conforming to ASTM A888 and Cast Iron Soil Pipe Institute Standard 301 and so marked.
 - 2. 2-1/2 inch and smaller: Schedule 40 galvanized steel pipe with black cast iron drainage fittings, or DWV copper pipe and fittings.
 - 3. Vent pipe buried in ground and to 6 inches above ground: Cast iron soil pipe and fittings conforming to ASTM A888 and Cast Iron Soil Pipe Institute Standard 301 and so marked. Joints in cast iron vent pipe shall be the same as specified for cast iron waste pipe below ground.
- E. Type DWV copper tubing or No-Hub cast iron pipe and fittings may be used for concealed rainwater leaders. Where no-hub piping is used, the fittings and couplings shall match those used for waste piping.
- F. Grease Waste (GW) and Vent (GV) Pipe Underground to 6 Inches Aboveground: George Fisher Sloane, Inc., "Fuseal PP," Orion Fittings, Inc., "Rionfuse CF," IPEX, Inc., "Enfield," or equal, Schedule 40 polypropylene pipe and fittings assembled with electrofusion joints. Piping shall comply with ASTM F1412.
- G. Grease Waste (GW) and Vent (GV) Pipe Aboveground:
 - 1. In inaccessible spaces or within walls, George Fisher Sloane, Inc., "Fuseal PP," Orion Fittings, Inc., "Rionfuse CF," IPEX, Inc., "Enfield," or equal, flame-retardant schedule 40 polypropylene pipe and fittings assembled with electrofusion joints. Piping shall comply with ASTM F1412.
 - 2. In accessible areas: George Fisher Sloan, Inc. "Fuseal PP," Orion Fittings, Inc. "Blueline," IPEX, Inc. "Labline," or equal, flame retardant Schedule 40 polypropylene drainage pipe and fittings, with mechanical joints. Piping shall comply with ASTM F1412.
 - 3. Vent pipe aboveground: 3 Inches and Larger: Service weight cast iron soil pipe and fittings; 2-1/2 inches and smaller: Schedule 40 galvanized steel pipe with black cast iron drainage fittings.
- H. Water Pipe (Tempered Water, Tempered Water Return, Hot Water, Hot Water Return and Cold Water): ASTM B88, Type L copper tubing, hard-temper, with wrought copper fittings. Provide full solder cup for all fittings. Capped or plugged outlets shall be Schedule 40 screwed brass. Water piping below slab: ASTM B88, Type K copper tubing, hard temper, with wrought copper fittings. At Contractor's option, pipe runs below slab having no branches may be ASTM B88, Type K annealed copper tubing without joints. See Section 22 00 50 for pipe protection requirements for below slab copper piping.

- I. Temperature and Pressure Relief Valve Piping: ASTM B88, Type L copper tubing, hard-temper, with wrought copper fittings. Provide full solder cup for all fittings. Capped or plugged outlets shall be Schedule 40 screwed brass.

- J. Gas Pipe: Schedule 40 black steel conforming to ASTM A53, with malleable iron threaded fittings above grade for piping 2 inch and smaller; welded piping below grade and for above grade piping larger than 2 inches, with Class 150 welding fittings.
 - 1. Appliance Flexible Connectors for Indoor Equipment Without External Spring Isolation:
 - a. Contractor may choose one of the following:
 - 1) Direct gas pipe connection.
 - 2) Appliance flexible connector:
 - a) Comply with ANSI Z21.24.
 - b) Polymer or hot-dipped PVC coated corrugated 304 stainless steel.
 - c) Operating-Pressure Rating: 0.5 psig.
 - d) End Fittings: Zinc-coated steel.
 - e) Maximum Length: 30 inches.
 - f) Manufacturers: Dormont, Series 30C, 31, 40C, 41, and 51, Brasscraft model ProCoat, or equal.
 - b. Provide with end connections compatible with equipment and piping system.
 - c. Equipment located in spaces normally accessible to building occupants, other than maintenance personnel, shall utilize direct gas pipe connection.
 - d. Provide anti-microbial PVC coating for use with appliances located in kitchen areas.
 - 2. Flexible Gas Connector for Outdoor Equipment Without External Spring Isolation:
 - a. Contractor may choose one of the following:
 - 1) Direct gas pipe connection.
 - 2) Corrugated stainless steel hose with 304 stainless steel braid covering, CSA certified. Metraflex model GASCT, Unisource Manufacturing series 400, or equal. Provide with end connections compatible with equipment and piping system.
 - 3. Flexible Gas Connector for Equipment with External Spring Isolation, Indoors and Outdoors:
 - a. Where Drawings indicate installation of mechanical equipment on spring isolation rails spring mounted curbs, or spring hangers, provide metal flexible connectors, Metraflex Metraloop, or equal by Unisource Mfg. Co., or Flexicraft Industries, CSA certified for 4 inches of movement in all directions.
 - 4. Flexible Gas Connection System for Movable Gas-Fired Cooking Equipment:
 - a. System shall include flexible PVC coated braided stainless steel hose, quick disconnect fitting, full port CSA certified ball valve, 2 swivel elbows, coiled steel restraining cable and mounting hardware. Assembly shall be certified per ANSI Z21.69/CSA 6.16, "Connectors for Movable Gas Appliances." Size as required for appliance connection, 48" minimum hose length. Install per manufacturer's instructions. Connectors shall be Dormont Safety System, T&S Safe-T-Link, or equal.

- K. Condensate Drain Piping:
 - 1. Inside buildings provide ASTM B88, Type L copper tubing and fittings. Provide Wye fittings with capped cleanout plug for tubing up to 1 inch size. Provide wrought or cast DWV fittings for sizes 1-1/4 inch and larger.
 - 2. Outside buildings provide ASTM B88, Type L copper pipe and fittings, cast iron drain pipe and fittings or Schedule 40 galvanized steel pipe and cast iron drain or vent fittings.
 - 3. Connect condensate drains to mechanical equipment per equipment manufacturer's recommendations; provide P-trap where required. Slope piping to drain, with 1 inch in 10 foot minimum pitch. Provide di-electric couplings or unions at connections to dissimilar materials.

4. Where Drawings indicate installation of mechanical equipment on spring isolation rails spring mounted curbs, or spring hangers, provide threaded metal connector at mechanical equipment, Metraflex Model SST, or equal by Unisource Mfg. Co., or Flexicraft Industries. Arrange flexible connection to ensure drainage of condensate, and support flexible connection at each end of connector, to ensure proper alignment.
 5. Where condensate drain P-traps are required, install trap using Wye fitting on inlet and outlet of trap. Provide cap on top of each Wye, made removable for cleaning and inspection. Drill 1/8 inch diameter hole in cap at outlet of the trap to allow venting of the system. Minimum depth of trap should be 4 inches, or as recommended by the manufacturer in printed literature.
 6. Provide cleanout tees or "Y" at each change in direction.
- L. Condensing-Type Equipment Condensate Drain Pipe: CPVC pipe and fittings conforming to ASTM D-2846.
1. Provide CPVC condensate drain pipe for condensing water heaters, furnaces, and where shown on Drawings.
 2. Provide continuous support for horizontal piping, B-line, Grinnell, or equal PVC coated channel systems, series B11 through B72 with matching pipe clamps as appropriate, or equal.
 3. Piping and fittings shall be as manufactured by Spears Manufacturing, Charlotte Pipe and foundry Co., or equal.

2.3 SITE PIPING AND FITTINGS TO 5 FEET FROM BUILDINGS

- A. Buried Drain, Waste, and Vent Piping:
1. Install piping from street connection to the property line in accordance with local requirements.
 2. 4 inches and larger: PVC, ASTM D3034 - SDR 35; use matching Ring Tite fittings.
 3. 3 inches and smaller: Cast iron soil pipe and fittings, asphaltic coated, conforming to ASTM A888 and Cast Iron Soil Pipe Institute Standard 301 and so marked. Pipe and fittings shall be as manufactured by AB&I, Charlotte, Tyler pipe, or equal. Provide ANACO-Husky SD 4000, Clamp-All 125, or equal couplings and No-Hub fittings, meeting the requirements of FM 1680, SD Class I and ASTM C1540. Pipe and fittings shall be the product of a single manufacturer.
- B. Grease Waste (GW) and Vent (GV) Pipe: George Fisher Sloane, Inc., "Fuseal PP," Orion Fittings, Inc., "Rionfuse CF," IPEX, Inc., "Enfield," or equal, polypropylene pipe and fittings assembled with electrofusion joints. Piping shall comply with ASTM F1412.
- C. Water Service Piping:
1. Sizes 2 inches and larger (not under building): Gasket style PVC conforming to ASTM D2241-SDR21, Class 200 with gasket type fittings or ductile iron mechanical joint couplings. Gasket fittings shall be one piece injection molded PVC fittings, equal to Flo-Seal water main fittings for PVC pressure pipe, 200 psi, ASTM D-3139.
 2. Sizes less than 2 inches: Type K copper tubing, hard temper, with wrought copper fittings. See Section 22 00 50 for pipe protection requirements for below grade copper piping.
 3. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - a. J.M. Eagle.
 - b. P.W. Pipe.
 - c. IpeX Series Pipe.
- D. Water Service Piping Above Grade:

1. Sizes 2 inches and larger: Class 150 flanged ductile cast iron water pipe conforming to AWWA/ANSI C150/A21.50 and manufactured in accordance with AWWA/ANSI C151/A21.51. Fittings shall conform to AWWA/ANSI C110/A21.10, Class 250 pattern. Pipe and fittings shall have factory applied cement-mortar lining in accordance with AWWA/ANSI C104/A21.4. Flanges shall conform to ASME/ANSI B16.1.
 2. Piping 1-1/2 inches and smaller: Type L copper tubing, hard temper, with brazed wrought copper fittings.
- E. Gas Piping Underground: Performance Pipe, "DriscoPlex" 6500 PE 2708 (yellow), Polypipe, Inc., "Polypipe", or equal, polyethylene gas distribution pipe, ASTM D2513, ASTM D3261, and ASTM D2683 fittings with fusion welded joints. Provide piping labeled for natural gas in accordance with CPC.
1. Electrically isolate underground ferrous gas piping from the rest of the gas system with listed or approved isolation fittings installed a minimum of six inches above grade.
 2. Provide Central Plastics Corp., Perfection, or equal, anodeless, single seal riser for transition from below grade polyethylene to schedule 40 steel piping above grade. Minimum horizontal length shall be 30 inches. Minimum vertical length shall be 30 inches, or greater as required. Provide fusion connection to polyethylene pipe below grade, and screwed connection to steel pipe above grade.
- F. Gas Piping Aboveground to 30 inches Belowground: Schedule 40 black steel with beveled ends for welding, with Class 150 welding fittings. Mitering to form elbows or tees will not be permitted; where branch tee connections of welded piping are required, Bonney "Weldolet" Allied Pipe Fittings, or equal fittings may be used if the branch is one-half of the diameter of the main or less.
- G. Drainage Pipe, Perforated or Un-perforated: J-M PVC, P.W. Pipe, or equal drainage pipe and fittings or non-reinforced concrete sewer pipe ASTM C14.

2.4 FIRE PROTECTION PIPING

- A. Refer to specification Section 21 10 00 "Fire Protection."

2.5 PIPE JOINING MATERIALS

- A. Refer to piping Articles in this Section for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated
 - a. Full-Face Type: For flat-face, Class 125, cast iron and cast bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast iron and steel flanges.
 2. AWWA C111, rubber, flat face, 1/8-inch (3.2mm) thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
 3. Flange Bolts and Nuts: AWWA C111, carbon steel, unless otherwise indicated.
 4. Plastic, Pipe-Flange Gasket, Bolts and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- C. Solder Filler Metals: ASTM B 32, 100 percent lead free alloys. Include water-flushable flux according to ASTM B813.
- D. Brazing Filler Metals: AWS A5.8, BCup-5 Series, copper-phosphorus unless otherwise indicated. Sil-Fos 15, or equal.

- E. Welding Filler Metals: Comply with ASME B31.1 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- F. Solvent Cements for Joining CPVC Piping: ASTM F 493.
 - 1. CPVC solvent cement shall have VOC content of 490 g/L or less.
 - 2. Adhesive primer shall have VOC content of 550 g/L or less.
 - 3. Solvent cement and adhesive primer shall comply with testing and product requirements of South Coast Air Quality Management District, Rule 1168.

2.6 VALVES AND FITTINGS FOR POTABLE WATER SYSTEMS

- A. General:
 - 1. Provide valves and fittings conforming to lead-free requirements of California Health and Safety Code Section 11 68 75.
 - a. Provide valves listed to NSF/ANSI 61-G or NSF/ANSI 372 for valve materials for potable-water service.
 - 1) Exception: Main distribution gate valves above 1-1/2 inches located underground outside building are not required to conform lead-free requirements of California Health and Safety Code Section 11 68 75.
- B. Gate Valves:
 - 1. General: Furnish valves in copper lines with adapters to suit valve/line requirements.
 - 2. 1-1/2 inches and smaller: Minimum 200 psi CWP, bronze body, threaded bonnet, rising or non-rising stem, solid wedge, threaded or solder ends, conforming to MSS SP-80. Milwaukee UP148, UP149, Nibco T-113-LF, S-113-LF, or equal.
 - 3. 2 inches through 3 inches: Minimum 200 psi CWP, bronze body, threaded bonnet, non-rising stem, solid wedge, threaded or solder ends, conforming to MSS SP-80. Nibco T-113-LF, S-113-LF, or equal.
 - 4. Main distribution gate valves underground outside building above 1-1/2 inches:
 - a. Underground valves 2 inches thru 12 inches: 250 psi, iron body, Non-rising stem, bolted bonnet, resilient wedge valves, conforming to AWWA C509, equipped with operating nuts, Mueller Series 2360, Nibco F-619-RW-SON, or equal.
 - 1) Underground valves 3 inches and smaller may be furnished with operating nuts or hand-wheels, and with Ring-Tite joint ends.
 - 2) Furnish and deliver to Owner one wrench of each size required for operating underground valves.
- C. Ball Valves:
 - 1. 2 inches and smaller: 600 psi CWP, cast bronze or brass body, full port, two piece, threaded ends, and reinforced PTFE seal, conforming to MSS SP-110. Nibco T-685-80-LF, Milwaukee UPBA400, Apollo 77C-LF10, Kitz 868, or equal.
 - 2. 2-1/2 inches: Apollo 77C-LF10, or equal.
- D. Swing Check Valves:
 - 1. Minimum 200 psi CWP, bronze or brass body, suitable for regrinding, threaded ends, conforming to MSS SP-80. Milwaukee UP509, Nibco T-413LF, Kitz 822T, or equal.
- E. Butterfly Valves:
 - 1. General: Tight closing, full lug type, with resilient seat suitable for minimum working pressure of 200 psig, conforming to MSS SP-67. Bi-direction dead end service with downstream flange removed.
 - 2. Provide valves with the following:
 - a. Seats: suitable for 40 degrees F for cold water service and 250 degrees F for hot water service. Seats shall cover inside surface of body and extend over body ends.

- b. Bodies: ductile iron or cast iron.
 - c. Discs: Bronze or stainless steel.
 - d. Stems or Shafts: Stainless steel. Install valves with stems horizontal.
 - e. Control Handles: Suitable for locking in any position or with 10 degree or 15 degree notched throttling plates to hold valve in selected position. Provide extended necks to compensate for insulation thickness. Provide gear operator for valves 5 inches and larger.
3. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
- a. 2 through 12 inches: Watts Regulator Co., model DBF-03.
- F. Silent Check Valves (for use on pump discharge):
- 1. General: Provide spring loaded check valves at pump discharge of all pumps.
 - a. 2 inches and smaller: Minimum 300 psi CWP, bronze body, Apollo 61LF, Milwaukee UP548-T, or equal.
 - b. 2-1/2 inches and larger: Class 250, cast iron body, suitable for regrinding, Mueller 103MAP, or equal.
- G. Calibrated Balancing Valves:
- 1. General: Calibrated orifice ball type rated for 400 psig maximum operating pressure and 250 degrees F. maximum operating pressure.
 - a. Body: Brass.
 - b. Ball: 304 Stainless Steel.
 - c. Seat: Glass and Carbon filled TFE.
 - d. End Connections: Threaded.
 - e. Pressure Gage connections: Integral capped readout valves with internal check valves and drain port, for use with portable pressure differential meter.
 - f. Handle Style: Dial, with memory stops to retain set position.
 - 2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - a. 1 inch and smaller: Bell & Gossett model CB, "LF" series.

2.7 VALVES AND FITTINGS FOR NON-POTABLE WATER, COMPRESSED AIR, AND GAS SYSTEMS

- A. Gate Valves:
- 1. 2-1/2 inches and smaller: Class150, bronze body, union bonnet, rising stem, solid wedge, threaded or solder ends, conforming to MSS SP-80. Hammond IB641, IB648, Nibco T-134, S-134, Milwaukee 1151, 1169, or equal.
 - 2. 3 inches and larger: Class 125, iron body, bronze mounted, bolted bonnet, non-rising stem, solid wedge, flanged ends, conforming to MSS SP-70. Hammond IR-1138, Nibco F619, Milwaukee F2882A, Stockham G-612, or equal.
 - 3. Underground valves 2 inches thru 12 inches: 250 psi, iron body, Non-rising stem, bolted bonnet, resilient wedge valves, conforming to AWWA C509, equipped with operating nuts, Mueller Series 2360, Nibco F-619-RW-SON, or equal.
 - a. Underground valves 3 inches and smaller may be furnished with operating nuts or hand-wheels, and with Ring-Tite joint ends.
 - b. Furnish and deliver to Owner one wrench of each size required for operating underground valves.
- B. Ball Valves:
- 1. 2 inches and smaller: 600 psi CWP, 150 psi SWP, cast bronze body, full port, two piece, threaded ends, and reinforced PTFE seal, conforming to MSS SP-110. Nibco T585-70, Milwaukee BA-400, Stockham T-285, or equal.

2. 2-1/2 inches and larger: Class 150, carbon steel body, full port, two piece, stainless steel vented ball, flanged ends, and reinforced PTFE seal, conforming to MSS SP-72. Nibco F-515-CS-F-66-FS, Milwaukee F20-CS-15-F-02-GO-VB, or equal.
 3. Compressed Air Services: 600 psi CWP, 150 psi SWP, bronze body, full port, three piece, threaded ends, and reinforced PTFE seal, conforming to MSS SP-110. Nibco Model T-595-Y, Milwaukee BA-300, or equal.
- C. Swing Check Valves: Class 125 or 150, bronze body, suitable for regrinding, threaded ends, conforming to MSS SP-80. Stockham B-321, Milwaukee 509, Nibco T-433, or equal.
- D. Butterfly Valves:
1. General: Tight closing, full lug type, with resilient seat suitable for minimum working pressure of 200 psig, conforming to MSS SP-67. Bi-direction dead end service with downstream flange removed.
 2. Provide valves with the following:
 - a. Seats: Suitable for 40 degrees F for cold water service and 250 degrees F for hot water service. Seats shall cover inside surface of body and extend over body ends.
 - b. Bodies: Ductile iron or cast iron.
 - c. Discs: Bronze or stainless steel.
 - d. Stems or Shafts: Stainless steel.
 - e. Control Handles: Suitable for locking in any position or with 10 degree or 15 degree notched throttling plates to hold valve in selected position. Provide extended necks to compensate for insulation thickness. Provide gear operator for valves 5 inches and larger.
 3. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - a. 2 through 12 inches: Milwaukee Valve, CL series, Nibco, Inc., Model LD2000-3, or equal.
- E. Silent Check Valves (for use on pump discharge):
1. General: Provide spring loaded check valves at pump discharge of all pumps.
 2. 2 inches and smaller: 250 psi CWP, bronze body, Nibco Model T-480, Milwaukee 548-T, or equal.
 3. 2-1/2 inches and larger: Class 250, cast iron body, wafer style, suitable for regrinding. Nibco Model F960, Milwaukee 1400, Mueller 103MAP, or equal.
- F. Calibrated Balance Valves (Symbol CBV): Provide globe style valves for precision regulation and control rated 175 psi for sizes 2-1/2 inches through 12 inches and rated 240 psi for bronze sizes 2 inches and below. Each valve shall have two metering/test ports with internal check valves and protective caps. All valves must be equipped with visual position readout and concealed memory stops for repeatable regulation and control.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - a. Bell & Gossett Circuit Setter Plus.
 - b. Armstrong CBV.
 - c. Flow Design Inc. Accusetter.
 - d. Tour & Andersson.
 - e. Circuit Sensor with butterfly valve above 3 inches.
 - f. Illinois Series 5000 through 2 inches.
- G. Flow Control Valves: Automatic pressure compensating flow control valves shall be Griswold, Flow Design, Inc., or equal.
- H. Building Gas Shut-Off Valves:

1. 2 inches and smaller: Provide 175 psi SWP ball valve, CSA listed, full port, lockwing type, with AGA painted grey finish. Jomar 175-LWN, or equal.
 2. Above 2 inches: Provide ReSun D-126, Key Port, or equal, lubricated plug cock, CSA listed, rectangular port, full pipe area, 125 psi SWP, flanged ends. Provide T-Handle socket wrench and adapter fittings as required for operation of valves. Provide one package of spare lubricant sticks, sizes as required for valve sizes. Lubricant shall be the product recommended by valve manufacturer for use with type of gas conveyed by the piping system.
 3. Provide valves same size as upstream piping. Make any reduction in size of gas piping downstream of shutoff valves.
- I. Gas Shut-off Valve Above Grade:
1. 2 inches and smaller: Provide Milwaukee BB2-100, Jomar T-100NE, or equal, ball valve, CSA listed, full port.
 2. Above 2 inches: Provide ReSun D-126, Key Port, or equal, CSA listed, rectangular port, full pipe area, 125 psi SWP, flanged ends. Provide T-Handle socket wrench and adapter fittings as required for operation of valves. Provide one package of spare lubricant sticks, sizes as required for valve sizes. Lubricant shall be the product recommended by valve manufacturer for use with type of gas conveyed by the piping system.
 3. Provide valves same size as upstream piping. Make any reduction in size of gas piping downstream of shutoff valves.
- J. For Gas Service Below Grade:
1. Lubricated plug cocks: ReSun Model D-126, Key Port, or equal, lubricated plug cock, CSA listed, rectangular port, full pipe area, 125 psi SWP, flanged ends. Provide extended lubrication stem, arranged to allow for lubrication of the valve from grade. The extension must be constructed to allow for lubrication of the valve and for operation of the valve from grade. Provide T-Handle socket wrench and adapter fittings as required for operation of valves. Provide one package of spare lubricant sticks, sizes as required for valve sizes. Lubricant shall be the product recommended by valve manufacturer for use with type of gas conveyed by the piping system.
 - a. Provide flanged ends on valves installed below grade. Connect to polyethylene piping with flanges and stainless steel bolts.
 - b. Anchor each valve flange to valve box with welded angle iron, or provide vertical stiff leg, minimum 18 inches into earth.
 - c. Provide Central Double O Seal Transition Fittings, or equal, flanged style for connection between valve and piping system.
 - d. Wrap valve, flanges and exposed pipe with PASCO Specialty & Mfg., Inc., or equal tape wrap, installed in accordance with requirements listed under "Pipe Protection".
- K. Seismic Gas Shut-Off Valves: Certified by State of California and compliant with ASCE 25. Provide standard or high pressure model as required to match site gas pressure. Provide unit arrangement per Drawings schedule and details.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Little Firefighter Corporation, models NAGV, VAGV, and AGV.
 - b. Seismic Safety Products, LLC, Northridge series.

2.8 DOMESTIC WATER PIPING SPECIALTIES

- A. Hose Bibbs:

1. Manufacturers: Drawing schedules indicate Basis of Design products. Subject to compliance with requirements, provide product indicated on Drawings, or comparable product by one of the following, or equal:
 - a. Acorn Engineering Co.
 - b. Woodford Manufacturing Co.
 2. Hose Station: Leonard THS-25-VB-CW, Symmons, or equal.
- B. Wall Hydrants:
1. Manufacturers: Drawing schedules indicate Basis of Design products. Subject to compliance with requirements, provide product indicated on Drawings, or comparable product by one of the following, or equal:
 - a. Acorn Engineering Co.
 - b. Woodford Manufacturing Co.
 - c. Mifab, Inc.
- C. Water Hammer Arrestors:
1. Provide water hammer arrestors conforming to lead-free requirements of California Health and Safety Code Section 11 68 75, with nesting type bellows contained within a casing having sufficient displacement volume to dissipate the calculated kinetic energy generated in the piping system. Water hammer arrestors shall be sized for type and number of fixtures served. Provide all stainless steel shell construction with stainless steel bellows and threaded connection to water system.
 2. Water hammer arrestors shall be certified under P.D.I. Standard WH201 and by ASSE Standard 1010.
 3. Select units in accordance with the requirements of Plumbing and Drainage Institute Standard P.D.I. WH201. Install above ceilings or behind wall access door at each plumbing fixture, or where plumbing fixtures are installed in groups, at each group of fixtures.
 4. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - a. Josam Company, series 75000.
 - b. Smith (Jay R.) Mfg. Co., Hydrotrol 5005-5050.
 - c. Mifab, series WHB.
- D. Water Filters:
1. Provide Cuno Incorporated, Aqua Pure model AP510, or equal, point of use water filters, conforming to lead-free requirements of California Health and Safety Code Section 11 68 75, in locations indicated on Drawings.
 - a. Provide model AP517 filter cartridge at each location, with 5 micron rating and 2,000 gallon rating, to remove sediment, rust, scale and chlorine taste and odor from incoming water. 2 gallon per minute capacity.
 - b. Provide one spare cartridge for each unit provided.
- E. Reduced Pressure Backflow Preventers for Potable Water Systems:
1. Provide reduced pressure principle backflow preventer conforming to lead free requirements of California Health and Safety Code Section 11 68 75.
 - a. Reduced-pressure principle backflow preventer assembly, consisting of shutoff valves on inlet and outlet, and strainer on inlet., Backflow preventer shall include test cocks, and pressure differential relief valve located between two positive seating check valves. Construct in accordance with ASSE Standard 1013.
 - b. Manufacturers: Subject to compliance with requirements and local water authorities having jurisdiction, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - 1) 2 inches and smaller: Wilkins 975XL2, Febco LF825YRP, Watts LF919.
 - 2) 2-1/2 thru 10 inches: Wilkins 475AXL, Febco LF860RP.

- 3) 2-1/2 and 3 inches: Watts LF009.
 2. Provide LeMeur, Hot-Box, WattsBox, or equal, two piece reinforced aluminum, fiberglass, welded angle with expanded metal, backflow preventer enclosure, sized to suit the size of backflow preventer. Install on concrete pad, in accordance with manufacturer's written installation instructions.
 3. Provide substantial padlock and chain to lock valves in open position, and turn key over to Project Inspector.
 - a. Padlocks shall be as specified under Section 08 70 00.
 - b. Chain shall be of carbon steel, 3/8 inch wire diameter, fully welded links and weight of 140 pounds per 100 lineal feet. Chain shall be hot galvanized.
 4. Provide capped connections at each test cock. Install in accordance with requirements of Authority Having Jurisdiction.
 5. For units installed within buildings, provide drain, connected to unit, to collect spillage from atmospheric vent. Run drain to nearest floor sink or drain.
 6. Provide two concrete filled, 6-inch diameter pipe bollards to protect all exposed piping from motor vehicle damage.
- F. Reduced Pressure Backflow Preventers for Non-Potable Water Systems:
1. Refer to Section 21 10 00 for backflow preventers for fire protection service.
 2. Provide reduced-pressure principle backflow preventer consisting of assembly, including shutoff valves on inlet and outlet, and strainer on inlet, equal to Febco 825Y or 880, as required Wilkins, Aames, or equal. Backflow preventer shall include test cocks, and pressure differential relief valve located between two positive seating check valves. Construct in accordance with ASSE Standard 1013.
 3. Provide LeMeur, Hot-Box, or equal, two piece backflow preventer enclosure, sized to suit the size of backflow preventer. Install on concrete pad, in accordance with manufacturer's written installation instructions.
 4. Provide substantial padlock and chain to lock valves in open position, and turn key over to Project Inspector.
 - a. Padlocks shall be as specified under Section 08 70 00.
 - b. Chain shall be of carbon steel, 3/8 inch wire diameter, fully welded links and weight of 140 pounds per 100 lineal feet. Chain shall be hot galvanized.
 5. Provide capped connections at each test cock. Install in accordance with requirements of Authority Having Jurisdiction.
 6. For units installed within buildings, provide drain, connected to unit, to collect spillage from atmospheric vent. Run drain to nearest floor sink or drain.
 7. Provide two concrete filled, 6-inch diameter pipe bollards to protect all exposed piping from motor vehicle damage.
 8. Manufacturers: Subject to compliance with requirements and local water authorities having jurisdiction, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - a. Ames.
 - b. Febco Sales, Inc.
 - c. Watts Regulator Company.
 - d. Clow.
- G. Double Check Valve Backflow Preventers:
1. Refer to Section 21 10 00 for backflow preventers for fire protection service.
 2. Provide double detector check valve assembly consisting of two spring loaded brass check valves, two cast iron bronze fitted gate valves and four test cocks, equal to Febco Model 856 or 876 as required. Construct in accordance with ASSE Standard 1048.
 3. Provide LeMeur, Hot-Box, or equal, two piece backflow preventer enclosure, sized to suit the size of backflow preventer. Install on concrete pad, in accordance with manufacturer's written installation instructions.

4. Provide substantial padlock and chain to lock valves in open position and turn key over to Project Inspector.
 - a. Padlocks shall be as specified under Section 08 70 00.
 - b. Chain shall be of carbon steel, 3/8 inch wire diameter, fully welded links and weight of 140 pounds per 100 lineal feet. Chain shall be hot galvanized.
 5. Provide capped connections at each test cock. Install in accordance with requirements of Authority Having Jurisdiction.
 6. Provide two concrete filled, 6 inch diameter pipe bollards to protect all exposed piping from motor vehicle damage.
 7. Provide Christy, or equal, utility box sized as required to suit backflow assembly, complete with two piece reinforced concrete lid, concrete extensions, insulation and other construction details shown on the drawings.
 8. Manufacturers: Subject to compliance with requirements and local water authorities having jurisdiction, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - a. Ames.
 - b. Febco Sales, Inc.
 - c. Watts Regulator Company.
 - d. Clow.
- H. Potable Water Pressure-Regulating Valve:
1. Provide pressure-regulating valves, single-seated, direct-operated type, bronze body, integral strainer, complying with requirements of ASSE Standard 1003, and the lead-free requirements of California Health and Safety Code Section 11 68 75. Size for maximum flow rate and inlet and outlet pressure indicated on Drawings.
 2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - a. Cla-Val Company.
 - b. Watts Regulator Company.
- I. Thermostatic Water Temperature Control Valve:
1. Provide thermostatic water temperature control valve conforming to lead free requirements of California Health and Safety Code Section 11 68 75, with size as noted on Drawings, complete with union angle strainer checkstops. Valves shall be thermostatic type, with a maximum temperature setting as follows:
 2. Provide surface recessed semi-recessed mounted, white enameled or stainless steel cabinet with locking door for control valves. Including:
 - a. Control valve cabinet and valve shall be provided as a package, and include thermostatic water mixing valve, thermometer, safety checkstops, volume control valve and internal piping.
 3. Where indicated on drawings, provide a temperature alarm system, utilizing a micro-processor based controller and solid state temperature controller. Provide audible and visual indication of high and low temperature set points. Provide required hardware and wiring for a complete operating system.
 - a. Provide isolation transformer for control of the alarm system.
 - b. Provide solenoid valve and shock absorber, installed and wired to the alarm module.
 4. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - a. Leonard Valve Company.
 - b. Lawler Manufacturing Co., Inc.
 - c. Powers.
- J. Relief Valves:

1. Provide relief valves as indicated, of size and capacity as selected by Contractor for proper relieving capacity, in accordance with ASME Boiler and Pressure Vessel Code.
 2. Combined Pressure-Temperature Relief Valves: Bronze body, test lever, thermostat, complying with ANSI A21.22 listing requirements for temperature discharge capacity. Provide temperature relief at 210 degrees F, and pressure relief at 150 psi.
 3. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - a. Watts Regulator Company.
 - b. Cash (A.W.) Valve Manufacturing Corporation.
 - c. Zurn Industries, Inc.; Wilkins-Regulator Division.
- K. Trap Primers:
1. Manufacturers: Drawing schedules indicate Basis of Design products. Subject to compliance with requirements, provide product indicated on Drawings, or comparable product by one of the following, or equal:
 - a. MiFab, Inc.
 - b. Precision Plumbing Products.
 - c. Sioux Chief Manufacturing Company.
- L. Water Meter:
1. Provide and install prefabricated water meter and bypass assembly, sized as indicated on the Drawings, complete with strainer, adapter, couplings, spool piece and test nipple. The meter shall be compound type, with two measuring chambers and a single billing register. Pipe materials used in construction of the assembly shall be ductile iron, and the meter shall be bronze with stainless steel trim.
 2. Install the meter and accessories in a Christy, Brooks, or equal, series "R" pit Model R37, 4 feet by 7 feet by 3 feet deep; complete with 4 piece checker plate parkway lid (screw down type), and 8 inch round meter reading lid. Install meter in accordance with the requirements of the Authority Having Jurisdiction.
 3. Manufacturers: Subject to compliance with requirements and local water authorities having jurisdiction, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - a. Badger Meter, Inc.
 - b. Sensus North America Water.
 - c. Neptune Technology Group.
 - d. Hershey Meters.

2.9 GAS PIPING SPECIALTIES

- A. Gas Pressure Regulating Valves:
1. Provide single-stage, spring-loaded, corrosion-resistant gas pressure regulators, with die-cast aluminum or cast iron body, complying with ANSI Z21.80. Unit shall be with atmospheric vent, internal relief overpressure protection, threaded ends for 2 inches and smaller, flanged ends for 2-1/2 inches and larger. For inlet and outlet gas pressures, specific gravity, and volume flow refer to Drawings schedule.
 2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:

<u>Size</u>	<u>Manufacturer/Model</u>
1/2 inch	Elster (American, Singer) model 1213B Itron (Actaris, Slumberger, Sprague) model B42R.
3/4 thru 1-1/4inches	Elster (American, Singer) model 1813C Sensus (Ivensys, Equimeter, Rockwell) model 143-80-12 Itron (Actaris, Slumberger, Sprague) models B42R, B57R, B58R
1-1/2 thru 2 inches	Elster (American, Singer) models 1813, 1813B Sensus (Ivensys, Equimeter, Rockwell) model 243 Itron (Actaris, Slumberger, Sprague) models B43SR, B34R, B38R

- B. Gas and Air Outlets:
1. Gas Outlets: Deck mounted Chicago 982-907BC duplex, T&S Brass, or equal; deck mounted Chicago 980-907BC single, or equal, deck-mounted Chicago 984-907BC, four outlets, or equal. Provide integral check valve, and single lever handle in compliance with ADA requirements.
 2. Air Outlets: Panel mounted Chicago 986-937CH; deck-mounted Chicago 980-937CH, T&S Brass, or equal. Provide integral check valve, and single lever handle in compliance with ADA requirements.

2.10 DRAIN AND WASTE PIPING SPECIALTIES

- A. Cleanouts:
1. General: Install cleanouts of same diameter as pipe (4 inch maximum) in all horizontal soil and waste lines where indicated and at all points of change in direction. Cleanouts shall be located not less than 18 inches from building construction so as to provide sufficient space for rodding. No horizontal run over 50 feet inside buildings or 100 feet outside buildings shall be without cleanout, whether shown on Drawings or not. Provide two-way cleanouts where indicated on drawings, and where required for satisfactory use.
 - a. Provide cleanouts in waste drop from each sink and urinal.
 - b. Provide one wrench for each size and type of cleanout used. Turn over to Owner at completion of the project, and obtain receipt. Place receipt in Operation and Maintenance Manuals.
 2. Cleanouts in floor and in concrete sidewalks: Ducco Cast Iron with nickel bronze top, clamping collar and ABS plastic plug: Zurn ZN-1400-KC, or equal, with square or round top to suit floor construction.
 3. Cleanouts in composition floors: Zurn ZN-1400-X-DX, or equal (nickel bronze top).
 4. Cleanouts in concealed, aboveground cast-iron soil or waste lines: Zurn Z-1440A, or equal, with ABS plastic plug.
 5. Cleanouts in walls: Zurn Z-1441 or Z-1443, or equal, with stainless steel cover. Provide long sweep elbow or combination wye at connection to riser and install with surface of cleanout within 1/2 inch of front face of finished wall.
 - a. Where space does not permit the above installation, provide Zurn Z-1446, or equal, with stainless steel access cover, and vandal resistant screw.
 - b. Install face of cleanout plug within 1/2 inch of front face of finished wall.

- B. Floor Drains:
 - 1. Manufacturers: Drawing schedules indicate Basis of Design products. Subject to compliance with requirements, provide product indicated on Drawings, or comparable product by one of the following, or equal:
 - a. J.R. Smith.
 - b. MIFAB.
 - c. Watts.
 - d. Zurn.

- C. Floor Sinks:
 - 1. Floor Sinks: Provide anchoring flange (seepage pan) at all floor sinks, and provide flashing clamp in locations where floor membrane is used. Provide cast iron "P" trap and trap primer connection at P-Trap.
 - 2. Manufacturers: Drawing schedules indicate Basis of Design products. Subject to compliance with requirements, provide product indicated on Drawings, or comparable product by one of the following, or equal:
 - a. J.R. Smith.
 - b. MIFAB.
 - c. Watts.
 - d. Zurn.

- D. Hopper Drains:
 - 1. Manufacturers: Drawing schedules indicate Basis of Design products. Subject to compliance with requirements, provide product indicated on Drawings, or comparable product by one of the following, or equal:
 - a. Zurn.
 - b. J.R. Smith.

- E. Area Drain:
 - 1. Manufacturers: Drawing schedules indicate Basis of Design products. Subject to compliance with requirements, provide product indicated on Drawings, or comparable product by one of the following, or equal:
 - a. Brooks.
 - b. J.R. Smith.
 - c. Old Castle Precast.
 - d. Watts.
 - e. Zurn.

- F. Roof Drains and Overflow Drains:
 - 1. See Architectural Drawings for drain style to be used.
 - 2. Provide offset downspout boots where required for connection of exposed sheet metal downspouts to underground cast iron or PVC piping.
 - 3. Provide rainwater leader nozzles on overflow piping. Nozzle body shall be bronze with threaded inlet and bronze wall flange with mounting holes. Size nozzle to match connected rainwater leader.
 - 4. Manufacturers: Drawing schedules indicate Basis of Design products. Subject to compliance with requirements, provide product indicated on Drawings, or comparable product by one of the following, or equal:
 - a. J.R. Smith.
 - b. Mifab.
 - c. Zurn.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions under which plumbing piping systems are to be installed. Do not proceed with Work until unsatisfactory conditions have been corrected in manner acceptable to Contractor.
- B. Make all arrangements for the utilities required. Pay all costs involved in obtaining the services including gas service and meter, water meter, pressure reducing valve, access boxes, street work. Connect to site utilities. Verify the location of all services. No extra cost will be allowed if services are not as shown.
- C. Determine sanitary sewer and storm drain location and elevation at all points of connection before installing any piping. Notify Architect immediately if indicated grades cannot be maintained.
- D. At time of final connection, and prior to opening valve to allow pressurization of water and gas piping from existing systems, on site or off site, perform a pressure test to indicate static pressure of existing systems. If pressure on water piping is greater than 80 psi, or gas pressure is not as indicated on Contract Documents, inform Architect immediately. Do not allow piping systems to be pressurized without written consent of the Architect.

3.2 INSTALLATION OF WATER PIPING

- A. Run all water piping generally level, free of traps or unnecessary bends, arranged to conform to the building requirements, and to suit clearance for other mechanical work such as ducts, flues, conduits, and other work. No piping shall be installed so as to cause unusual noise from the flow of water therein under normal conditions.
- B. Provide manufactured water hammer arrestors, sized and installed in accordance with Plumbing and Drainage Institute Standard PDI WH201.
 - 1. Locate water hammer arrestors at every plumbing fixture, or, where fixtures are located in groups, at every group of fixtures, and as indicated on Drawings.
 - 2. Install water hammer arrestors above accessible ceilings, or install access doors for service.
- C. In freezing locations arrange water piping to drain as shown.
- D. Install piping on room side of building insulation.
- E. Check final location of rubber rings within couplings on PVC water piping with gauge or as recommended by manufacturer. Make connection to valves with cast iron adapters connected to water pipe with cast iron couplings. Furnish and install anchors or thrust blocks.
- F. For all faucets, hose bibbs, or other water outlets delivering industrial hot and/or cold water, provide a sign, permanently mounted, indicating "CAUTION: NON-POTABLE WATER, DO NOT DRINK". Each sign shall be permanently engraved with black uppercase letters on a yellow background. Letters shall be minimum 1-1/4 inch high.

3.3 INSTALLATION OF SANITARY AND STORM DRAINAGE SYSTEMS

- A. Sewer Piping: Run all horizontal sanitary drain piping inside of building on a uniform grade of not less than 1/4 inch per foot unless otherwise noted or later approved. Unless otherwise noted on the plans, piping shall have invert elevations as shown and slope uniformly between given elevations.
- B. Storm Drain Piping: Run all horizontal storm drain piping inside of building on a uniform grade of not less than 1/4 inch per foot. Unless otherwise noted on the plans, piping shall have invert elevations as shown and slope uniformly between given elevations.
- C. Install rainwater leader nozzles at exposed bottom of leaders where they spill onto grade.
- D. Run all drainage piping as straight as possible and provide easy bends with long turns; make all offsets at an angle of 45 degrees or less.
- E. Grade all vent piping so as to free itself quickly of any water condensation.
- F. Where possible, join groups of vent risers together with one enlarged outlet through roof. Maintain minimum of 10 foot horizontal or 3 foot vertical clearance from air intakes.
- G. Install drip pan under storm drain piping, sanitary drain piping, and vent piping that must be run over kitchen areas.
- H. Hubless Cast Iron Joints: Comply with coupling manufacturer's installation instructions.

3.4 INSTALLATION OF GREASE WASTE PIPING SYSTEMS

- A. Install to comply with all manufacturers' recommendations.
- B. All buried pipe shall be bedded in and backfilled with 4 inches of sand, and installed as recommended by manufacturer.
- C. Install piping at concrete slabs or footings with 1 inch minimum polystyrene surrounding piping.
- D. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Maintain continuous pressure test on piping installed below grade, until all work has progressed to above grade.
- E. Electrofusion joints: Make polypropylene drainage piping joints according to ASTM F 1290.

3.5 INSTALLATION OF NATURAL GAS PIPING

- A. Install natural gas piping in accordance with Division 22 Basic Plumbing Materials and Methods sections.
- B. Use sealants on metal gas piping threads that are chemically resistant to natural gas. Use sealants sparingly, and apply to only male threads of metal joints.
- C. Remove cutting and threading burrs before assembling piping.
- D. Do not install defective piping or fittings. Do not use pipe with threads that are chipped, stripped, or damaged.

- E. Plug each gas outlet, including valves, with threaded plug or cap immediately after installation and retain until continuing piping or equipment connections are completed.
- F. Ground gas piping electrically and continuously within project, and bond tightly to grounding connection.
- G. Install drip-legs in gas piping where indicated and where required by code or regulation.
 - 1. Install "Tee" fitting with bottom outlet plugged or capped at bottom of pipe risers.
 - 2. Where gas supply is connected to equipment with flexible connectors, install drip-leg in piping on downstream side of flexible connector, and install shut off valve on piping on upstream side of flexible connector.
- H. Install piping with 1/64 inch per foot (1/8 percent) downward slope in direction of flow.
- I. Install piping parallel to other piping.
- J. Paint all gas piping installed in exposed exterior locations. For additional requirements, refer to Section 22 00 50, Basic Plumbing Materials and Methods, article, Painting.
- K. Provide shutoff valve downstream of meter.
- L. Provide exterior shutoff valve at each building. Provide sign affixed to wall at valve location reading: "Gas Shut-Off." Size and location of the sign shall be as required by the Authority Having Jurisdiction. Where gas piping enters a building in more than one location, exterior shutoff valves shall have a permanently attached metal tag identifying the area served by that valve, in addition to sign on wall.
- M. Provide watertight Schedule 40 PVC conduit to protect gas piping installed below covered walk, covered driveways, and where noted on Drawings. Extend sleeve at least 12 inches beyond any area where it is required to be installed, and terminate with valve box extended to grade, and marked "GAS".
- N. Maintain minimum of 12 inch clearance between gas piping and steam piping above 200 degrees F.

3.6 PIPE JOINTS AND CONNECTIONS

- A. General:
 - 1. Cutting: Cut pipe and tubing square, remove rough edges or burrs. Bevel plain ends of steel pipe.
 - 2. Remove scale, slag, dirt and debris from inside and outside of pipe before assembly.
 - 3. Boss or saddle type fittings or mechanically extracted tube joints will not be allowed.
- B. Threaded Pipe: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply thread compound to external pipe threads: Rectorseal No. 5, Permatex No. 1, or equal.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- C. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

- D. Joint Construction for Solvent-Cemented Plastic Piping: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.
 - 2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.

- E. Copper Pipe and Tubing (Except pneumatic control piping): All joints shall be brazed according to ASME Section IX, Welding and Brazing Qualifications, except domestic water piping 1-1/4 inches and smaller when not buried in the ground or concrete and type DWV plumbing piping may be soldered.
 - 1. Soldered joints: Apply water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828.

- F. Cast Iron Soil Pipe:
 - 1. No-Hub fittings shall be made with a torque wrench.
 - 2. Hub joints shall be with Ty-Seal couplings.
 - 3. Wrought iron, steel, or copper pipe shall have a ring or part of a coupling screwed on to form a spigot end if caulked into a joint.
 - 4. Connect cast iron sewer piping to outside service pipe with cast iron or vitrified LOP reducers or increasers as required. Caulking of smaller pipe into the larger without a reducer or increaser will not be permitted.

- G. Welded Pipe:
 - 1. Make up with oxyacetylene or electric arc process.
 - 2. All line welds shall be of the single "V" butt type. Welds for flanges shall be of the fillet type.
 - 3. Where the branch is two pipe sizes smaller than the main or smaller, Bonney Weldolets, Thredolets, Nibco, or equal, may be used in lieu of welding tees.

- H. Polyethylene and Polypropylene Pipe: Assemble with fusion joints in strict accordance with manufacturer's instructions.

- I. Flexible Connections:
 - 1. Furnish and install Thermo Tech., Inc. F/J/R, Metraflex, or equal, flexible couplings with limiter bolts on piping connections to all equipment mounted on anti-vibration bases, on each connection to each base mounted pump and where shown. Couplings shall be suitable for pressure and type of service.
 - 2. Anchor piping securely on the system side of each flexible connection.

3.7 INSTALLATION OF VALVES

- A. Install valves as indicated on Drawings and in the following locations:
 - 1. Shutoff Valves: Install on inlet of each plumbing equipment item, and on inlet of each plumbing fixture, and elsewhere as indicated.
 - 2. Drain Valves: Install on each plumbing equipment item located to completely drain equipment for service or repair. Install at base of each riser, at base of each rise or drop in piping system, and elsewhere indicated or required to completely drain potable water system.
 - 3. Provide gate or globe valves on inlet and outlet of each water heater or pump.

- B. General:
 - 1. Valves shall be full line size unless indicated otherwise on Drawings.
 - 2. Install horizontal valves with valve stem above horizontal, except butterfly valves.
 - 3. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

4. Locate valves for easy access and provide separate support where necessary.
 5. Install valves in position to allow full stem movement.
 6. Install exposed polished or enameled connections with special care showing no tool marks or exposed threads.
 7. Butterfly valves conforming to the paragraph "Butterfly Valves" may be used in lieu of gate or globe valves for locations above grade.
 8. Ball valves conforming to the paragraph "Ball Valves" may be used in lieu of gate valves for locations above grade for services 2-1/2 inches and smaller.
 9. Valves 2-1/2 inches and smaller (except ball valves) in nonferrous water piping systems may be solder joint type with bronze body and trim.
 10. Rigidly fasten hose bibbs, hydrants, fixture stops, compressed air outlets, and similar items to the building construction.
- C. Gate Valves:
1. Furnish valves in copper lines with adapters to suit valve / line requirements.
 2. Underground gate valves:
 - a. Underground valves 3 inches and smaller may be furnished with operating nuts or hand-wheels, and with Ring-Tite joint ends.
 - b. Furnish and deliver to Owner one wrench of each size required for operating underground valves.
- D. Swing Check Valves: Install in horizontal position with hinge pin level.
- E. Butterfly Valves: Install with stems horizontal.
- F. Silent Check Valves: Install in horizontal or vertical position between flanges.
- G. Calibrated Balancing Valves: Install calibrated balancing valves per manufacturers' recommendations, including requirements for straight pipe lengths at valve inlet and outlet.
- H. Gas Shut-Off Valves:
1. Provide line size ball valve in gas line to each appliance.
 2. Provide line size electric solenoid gas valve in gas line to kitchen equipment (if not supplied with appliance) under Type 1 hood. Interlock with hood fire alarm system.
- I. Valve Adjustment: Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.8 INSTALLATION OF CLEANOUTS

- A. Cleanouts: Install in piping as indicated, as required by California Plumbing Code, at each change in direction of piping greater than 45 degrees. Install at maximum intervals of 50 feet for piping 4 inches and smaller and 100 feet for larger piping inside buildings, and at base of each conductor.
- B. Flashing Flanges: Install flashing flange and clamping device with each cleanout passing through water resistant membrane.

3.9 INSTALLATION OF FLOOR DRAINS AND FLOOR SINKS

- A. Install drains in accordance with manufacturer's written instructions and in locations indicated. Install floor drains with lip of drain slightly below finished floor to ensure drainage. Install floor sinks flush with finished floor. Coordinate with other trades to ensure that floor slopes to drain. Provide flashing flange and clamping device with each drain passing through water resistant membrane.
- B. Install vented P-trap below each drain. Where trap primers are indicated, install trap primer connection in the P-trap.

3.10 INSTALLATION OF ROOF DRAINS AND OVERFLOW DRAINS

- A. Install roof drains and overflow roof drains in accordance with manufacturer's written instructions and in locations indicated.
- B. Coordinate with roofing as necessary to interface roof drains with roofing work.

3.11 INSTALLATION OF HOPPER DRAINS

- A. Install hopper drain in wall, in sheet metal box, with access door.
 - 1. Size access door and box to suit the size required for hopper drain and trap primer, and solder all seams of box. Seal all penetrations to box with non-hardening waterproof sealant. Provide locking door in occupied spaces.
- B. Grind top and sides of funnel, if required, to suit wall thickness.

3.12 BACKFLOW PREVENTER INSTALLATION

- A. Install backflow preventers where indicated on Drawings. Provide drain connection available from the manufacturer at drain connection, pipe drain outlet to the nearest floor drain.
 - 1. Where drain pans are shown on the Drawings, pipe drain pan outlet to nearest floor drain.

3.13 TRAP PRIMER INSTALLATION

- A. Install as indicated in manufacturers printed literature, with 1/2 inch, Type L, hard copper piping to trap primer connection on floor drains and floor sinks where indicated on Drawings. At Contractor's option, Type K annealed copper tubing without joints may be used below slab only. See Section 22 00 50 for pipe protection requirements for below slab copper piping/tubing.
- B. Install trap primer piping with 1/4 inch per foot slope, to insure that the line will drain fully to the floor drain or floor sink.
 - 1. Provide ball valve to the inlet at each trap primer location.
- C. Install trap primer and distribution unit exactly as called for in manufacturers printed installation instructions. Connect to domestic water piping from the top of the water line, in order to prevent foreign material from entering directly into primer assembly.
- D. Mount trap primer in wall, in sheet metal box, with Karp or equal access door. Size access door and box to suit valve operation, and solder all seams of box. Seal all penetrations to box with non-hardening waterproof sealant. Provide locking door where installed in occupied spaces.

- E. Where one trap primer will be used for more than one trap, provide a distribution unit with feeder piping for a maximum of four traps sized for equal pressure drop to each trap.

3.14 INSTALLATION OF GAS PRESSURE REGULATING VALVES

- A. Install as indicated; comply with utility requirements. In locations where regulators are installed in confined spaces, pipe atmospheric vent to outdoors, full size of outlet. Install gas shutoff valve upstream and downstream of each pressure-regulating valve.

3.15 GAS PIPING EQUIPMENT CONNECTIONS

- A. Connect gas piping to each gas-fired equipment item, with union, drip leg and shutoff gas cock full size of supply line shown. Reduce only at connection to equipment. Comply with equipment manufacturer's instructions.
 - 1. Route gas vent and gas relief to outside.
 - 2. Gas shutoff valve shall be placed as close as possible to equipment in a location where it can be serviced. Distance from equipment to valve shall not exceed 6 feet.

3.16 EQUIPMENT CONNECTIONS

- A. Piping Runouts to Fixtures: Provide hot and cold water piping runouts to fixtures of sizes indicated.
- B. Mechanical Equipment Connections: Connect hot and cold water piping system and gas piping system to mechanical equipment as indicated, and provide with shutoff valve and union for each connection.

3.17 KITCHEN EQUIPMENT INSTALLATION

- A. Coordinate all work with Specification Section for Kitchen Equipment.
- B. All equipment shall be fully connected.
- C. Furnish and install all required "P" traps.
- D. Provide stops on all hot and cold water lines at equipment, in an accessible position. Include lines to kettle and range swing faucets.
- E. Water pressure for dishwasher and glass-washer to be 25 pound maximum. Provide pressure reducing valves on water line to washers.
- F. All floor openings are to be sealed watertight.
- G. Indirect waste lines required for standard or fabricated items of kitchen equipment, except sinks, shall be furnished and installed by the Kitchen Equipment Contractor.
- H. Provide all sink drains. All indirect drains shall terminate above floor sinks at least 1-1/2 times ID of drain line and shall be so set that flare will not spill on floor area.
- I. Provide approved vacuum breaker or anti siphon device on water lines to equipment wherever required.

- J. Provide gas pressure regulators for modular front manifold cooking equipment assemblies. Pressure regulators shall be adjustable from 2 inch to 7 inch water column and shall be set for approximately 6 inches W.C. at manifold connection.
- K. All gas pressure regulators shipped loose with gas fired equipment shall be installed by Plumbing Contractor.
- L. The Kitchen Equipment Contractor will provide all equipment trim including faucets and sink wastes and swing faucets at kettles all to be installed by Plumbing Contractor.
- M. All horizontal piping lines connected to equipment shall be run at the highest possible elevation not less than 6 inches above floor. Piping rough-in shall be stubbed in walls wherever possible.
- N. Vent piping for waste lines shall be concealed wherever possible and vertical vents for island or free-standing equipment shall be avoided. Any required exposed vents shall be submitted to the Architect for approval.
- O. Kitchen Equipment Contractor to furnish coffee maker. Plumbing Contractor shall provide a cold water connection terminating in a 3'-0" length of 1/4 inch OD soft copper tubing with a 1/4 inch female flare fitting on the end.
- P. Fire protection systems for ventilators and cooking equipment are furnished and installed by Kitchen Equipment Contractor unless shown otherwise on the drawings. Gas valves which are a part of the fire protection systems are furnished only. Plumbing Contractor shall install gas valves.
- Q. Connect movable gas-fired cooking equipment utilizing flexible gas connection system.

3.18 DOMESTIC WATER SYSTEM STERILIZATION

- A. Clean and disinfect new or altered hot and cold water piping connected to domestic water systems using methods prescribed by the Health Authority. If the Health Authority does not prescribe methods, clean and disinfect new or altered hot and cold water piping using methods given in the California Plumbing Code.
 - 1. A water treatment company that has a current state EPA license to apply disinfectant chlorine in potable water shall perform the procedure.

3.19 CARE AND CLEANING

- A. Repair or replace broken, damaged, or otherwise defective parts, materials, and work. Leave entire work in condition satisfactory to Architect. At completion, carefully clean and adjust equipment, fixtures, and trim that are installed as part of this work. Remove labels from stainless steel sinks, except 316 stainless steel sink labels should be retained to confirm that the correct material has been provided. Leave systems and equipment in satisfactory operating condition.

3.20 OPERATIONAL TESTS

- A. Test each piece of equipment to show that it will operate in accordance with indicated requirements.

3.21 TESTING AND BALANCING

- A. See Section 23 05 93 of Specifications for testing and balancing requirements.

3.22 CLEANING UP

- A. Upon completion of Work remove materials, equipment, apparatus, tools, and the like, and leave premises clean, neat, and orderly.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Water supplies and stops.
 - 2. Plumbing fixture hangers and supports.
 - 3. Refrigerator ice maker outlet boxes.
 - 4. Dishwasher air gap fittings.
 - 5. Washing machine hose/supply boxes.

1.2 RELATED REQUIREMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 22 00 50 Basic Plumbing Materials and Methods.

1.3 ACTION SUBMITTALS

- A. For additional requirements, refer to Section 22 00 50, Basic Plumbing Materials and Methods.
- B. Product Data: Submit manufacturer's specifications for plumbing fixtures and trim, including catalog cut of each fixture type and trim item furnished.

1.4 INFORMATIONAL SUBMITTALS

- A. Refer to Section 22 00 50, Basic Plumbing Materials and Methods.

1.5 CLOSEOUT SUBMITTALS

- A. For additional requirements, refer to Section 22 00 50, Basic Plumbing Materials and Methods.
- B. Maintenance Data: Submit maintenance data and parts lists for each fixture type and trim item, including instructions for care of finishes. Include this data in Operation and Maintenance Manual.

1.6 QUALITY ASSURANCE

- A. For additional requirements, refer to Section 22 00 50, Basic Plumbing Materials and Methods.
- B. Plumbing Fixture Standards: Comply with applicable portions of the following codes and requirements for all work in this Section:
 - 1. California Building Code – CBC
 - 2. California Plumbing Code – CPC
 - 3. California Health and Safety Code
 - 4. American National Standards Institute - ANSI
 - 5. Federal Standards - F.S.
 - 6. National Sanitary Foundation – NSF International

- C. ANSI Standards: Comply with ANSI/NSF 61, "Drinking Water System Components – Health Effects."
- D. PDI Compliance: Comply with standards established by Plumbing and Drainage Institute pertaining to plumbing fixture supports.
- E. UL Labels: Provide water coolers that have been listed and labeled by Underwriters' Laboratories.
- F. ARI Labels: Provide water coolers that are rated and certified in accordance with applicable Air-Conditioning and Refrigeration Institute Standards.
- G. Americans with Disabilities Act (ADA).
- H. California Green Building Standards Code Requirements:
 - 1. Tank-type water closets shall be certified to the performance criteria of the U.S. EPA WaterSense Specification for Tank-Type Toilets.
 - 2. Single Showerheads shall be certified to the performance criteria of the U.S. EPA WaterSense Specification for Showerheads.

PART 2 - PRODUCTS

2.1 PLUMBING FIXTURES

- A. General: Provide factory fabricated fixtures of type, style and material indicated. For each type fixture, provide fixture manufacturer's standard trim, carrier, seats, and valves as indicated by their published product information; either as designed and constructed, or as recommended by the manufacturer, and as required for a complete, installation. Where more than one type is dedicated, selection is Contractor's option; but, all fixtures of same type must be furnished by single manufacturer.
 - 1. Take special care with the roughing-in and finished plumbing where batteries of fixtures occur.
 - 2. Take location and mounting heights for roughing-in from Architectural Drawings.
 - 3. Follow schedule on Plumbing Drawings for roughing-in connections. Set roughing-in for all fixtures exactly as per measurements furnished by the manufacturers of the fixtures used.
 - 4. Roughing-in for lavatories and sinks shall be brought in through the wall under the centerline of the drain from the fixture wherever possible and as close to the fixture as possible.

2.2 MATERIALS

- A. Provide materials that have been selected for their surface flatness and smoothness. Exposed surfaces that exhibit pitting, seam marks, roller marks, foundry sand holes, stains, discoloration, or other surface imperfections on finished units are not acceptable.
- B. Where fittings, trim and accessories are exposed or semi-exposed, provide, chromium plated 17 gauge seamless brass and match faucets and fittings. Provide 17 gauge seamless copper or brass where not exposed.
- C. Handles on all faucets and stops shall be all metal chromium plated.
- D. NSF Standard: Comply with NSF 61 and NSF 372 for supply-fitting materials that will be in contact with potable water.

2.3 PLUMBING FITTINGS, TRIM AND ACCESSORIES

- A. Water Outlets: At locations where water is supplied (by manual, automatic or remote control), provide commercial quality faucets, valves, or dispensing devices, of type and size indicated, and as required to operate as indicated.
 - 1. Include manual shutoff valves and connecting stem pipes to permit outlet servicing without shut-down of water supply piping systems.
- B. P-Traps: Include IAPMO approved removable P-traps where drains are indicated for direct connection to drainage system. P-Traps shall be less trap screw cleanout, and incorporate a chrome plated cast brass body, brass connection nuts, 17 gauge seamless brass wall return and chrome plated wall escutcheon to match trap finish.
- C. Carriers: Provide cast iron supports for fixtures of graphitic gray iron, ductile iron, or malleable iron as indicated. Where the carrier for wall mounted water closets are installed more than 6 inches behind the finished wall, provide water closet support for wide pipe chase.
- D. Fixture Bolt Caps: Provide manufacturer's standard exposed fixture bolt caps finished to match fixture finish.
- E. Escutcheons: Where fixture supplies and drains penetrate walls in exposed location, provide chrome-plated cast brass escutcheons with setscrews.
- F. Aerators: Provide aerators of types approved by Health Departments having jurisdiction. Delete aerators where not allowed by CPC for health care occupancies.
- G. Comply with additional fixture requirements contained in Fixture Schedule shown on the drawings.

2.4 MANUFACTURERS

- A. In accordance with California Plumbing Code, provide indelibly marked or embossed manufacturers name or logo, arranged so as to be visible after installation.
- B. Manufacturers: Drawing schedules indicate Basis of Design products. Subject to compliance with requirements, provide product indicated on Drawings, or comparable product by one of the following:
 - 1. Vitrified China Plumbing Fixtures:
 - a. American Standard, U.S. Plumbing Products.
 - b. Eljer Plumbingware Div., Wallace-Murray Corp.
 - c. Kohler Co.
 - d. VitrA.
 - 2. Modular Lavatories:
 - a. Bradley.
 - b. Acorn.
 - c. Willoughby Industries, Inc.
 - 3. Plumbing Trim:
 - a. McGuire Manufacturing Co., Inc.
 - b. Delta Commercial.
 - c. Chicago Faucet Co.
 - d. T&S Brass and Bronze Works, Inc.
 - 4. Flush Valves:
 - a. Sloan Valve Co.
 - b. Zurn Industries, Hydromechanics Div.

- c. Toto USA, Inc.
- 5. Faucets:
 - a. Chicago Faucet Co.
 - b. Symmons Scott.
 - c. T&S Brass and Bronze Works, Inc.
 - d. Delta Commercial.
- 6. Fixture Seats:
 - a. Church Seat Co.
 - b. Bemis Mfg. Co.
 - c. Beneke Corp.
- 7. Water Coolers and Drinking Fountains:
 - a. Haws Corporation.
 - b. Halsey Taylor Mfg. Co.
 - c. Elkay Mfg. Co.
 - d. Acorn Aqua.
- 8. Service Sinks:
 - a. American Standard.
 - b. Kohler Co.
 - c. Williams Serviceceptor.
 - d. Florestone.
 - e. Acorn.
- 9. Stainless Steel Sinks:
 - a. Elkay Mfg. Co.
 - b. Just Mfg. Co.
 - c. Haws Corporation.
- 10. Showers:
 - a. Acorn.
 - b. Bradley.
 - c. Symmons.
 - d. Powers.
- 11. Emergency Equipment:
 - a. Haws Corporation.
 - b. Gardian.
 - c. Symmons.
 - d. Bradley.
 - e. Encon.
- 12. Fixture Carriers:
 - a. Josam Mfg. Co.
 - b. J. R. Smith.
 - c. Tyler Pipe; Wade Div.
 - d. Zurn Industries; Hydromechanics Div.
 - e. Mifab, Inc.

2.5 FLUSH VALVE REQUIREMENTS

- A. Metering flush valves where required and specified shall be non-hold open type with exposed parts chrome plated. Conform to all codes and manufacturers' recommendations. All diaphragms are to have multiple filtered bypass and be chloramine resistant synthetic rubber with internal components suitable for 180 degree hot water to 150 pounds pressure, plastic or leather diaphragm not acceptable.

- B. Electronic flush valves where required and specified shall be non-hold open type with exposed parts chrome plated. Conform to all codes and manufacturers' recommendations. All diaphragms are to have multiple filtered by pass and be chloramine and resistant synthetic rubber with rubber and internal components suitable for 180 degree hot water to 150 pounds pressure, plastic or leather diaphragm not acceptable. All flush valve solenoids and sensors shall be UL listed.

2.6 FIXTURE CONNECTIONS

- A. Make connection between fixtures and flanges on soil pipe absolutely gastight and watertight with neoprene type gaskets (wall hung fixtures) or bowl wax (floor outlet fixtures). Rubber gaskets or putty will not be permitted.
- B. Provide fixtures not having integral traps with P-traps of chromium-plated 17 gauge cast brass, with 17 gauge seamless brass wall return, connected to concealed waste in wall and sanitary fittings. Provide IAPMO approval for trap, and provide less trap screw cleanout.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - a. Dearborn Brass, Commercial series with brass nuts.
 - b. Delta Commercial.
 - c. McGuire Manufacturing Co., Inc.
- C. Connections from stacks or horizontal wastes to wall or floor finish for wastes from lavatories, urinals, sinks, and drinking fountains and connection between floor drains and traps shall be IPS 85 percent red brass pipe.
- D. Plumbing fixture traps connected to special waste systems shall be constructed of materials to suit the waste system.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - a. Orion.
 - b. Enfield
- E. Unions on waste pipes on fixture side of traps may be slip or flange joints with soft rubber or lead gaskets. Traps shall rough in full size to waste and vent connection, using deep escutcheon plate to cover wall penetration. Compression adaptor extensions or sweat adaptors are not acceptable.

2.7 WATER SUPPLIES AND STOPS

- A. Provide 85 percent IPS threaded red brass nipple, conforming to the lead-free requirements of California Health and Safety Code Section 11 68 75, securely anchored to building construction, for each connection to stops, hose bibbs, etc. Each fixture, except hose bibbs, shall have stop valves installed on water supply lines.
- B. Provide water supplies to fixtures with compression shut-off stops with threaded inlets and lock shield-loose key handles. Provide combination fixtures with compression stop and threaded inlet on each water supply fitting. Provide lock shield-loose key handle for each stop.
- C. Provide 1/2 inch riser tubes with reducing coupling for fixtures, unless otherwise noted.
- D. Provide cast brass escutcheon.

- E. Furnish shut-off valves on hose bibbs where directly connected to mains with no intervening valves.
- F. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - 1. McGuire Manufacturing Company, Inc., model LFH2167LK.
 - 2. T & S Brass and Bronze Works, Inc., model B-1305.

2.8 PLUMBING FIXTURE HANGERS AND SUPPORTS

- A. Residential type fixture supports are not acceptable.
- B. Install wall mounted water closets with combination support and waste fittings, with feet of support securely anchored to floor.
- C. Install floor mounted water closets with J.R. Smith, Zurn, or equal government pattern cast iron closet flanges with brass bolts, nuts, washers, and porcelain caps secured with Spackle.
- D. Install the following fixtures on concealed support with feet of support securely anchored to floor. Anchor top of support to wall construction in an approved manner.
 - 1. Wall hung lavatories.
 - 2. Wall mounted urinals.
 - 3. Drinking fountains.
 - 4. Electric water coolers.

2.9 PLUMBING FIXTURES

- A. Install all plumbing fixtures at height indicated on Architectural Drawings. Where mounting height is not indicated, install at height required by Code.
- B. Special Requirements For Accessible Fixtures:
 - 1. Operating handle or valve for accessible water closets, urinals, lavatories, and sinks shall operate with less than 5 pounds force. Metering faucets shall be adjusted to operate between 10 and 15 seconds.
 - 2. Insulate exposed waste piping and domestic water supplies below accessible fixtures with CBC access code compliant molded "closed-cell" vinyl covers. Covers shall be installed using vandal resistant fasteners and must be removable. Covers shall meet flame spread rating not to exceed 25 and smoke density not to exceed 50 when tested in accordance with ASTM E-84, and shall comply with the requirements of California Code of Regulations, Title 24. Plumberex – Handy Shield, Johns Manville – Zeston 2000, or equal.
- C. Refrigerator Ice Maker Outlet Boxes:
 - 1. Manufacturers: Drawing schedules indicate Basis of Design products. Subject to compliance with requirements, provide product indicated on Drawings, or comparable product by one of the following, or equal:
 - a. Guy Gray.
 - b. Water-Tite.
- D. Dishwasher Air Gap Fittings:
 - 1. Manufacturers: Drawing schedules indicate Basis of Design products. Subject to compliance with requirements, provide product indicated on Drawings, or comparable product by one of the following, or equal:
 - a. Zurn Industries, LLC.

- b. Dearborn Brass.
- E. Washing Machine Hose/Supply Boxes:
 - 1. Manufacturers: Drawing schedules indicate Basis of Design products. Subject to compliance with requirements, provide product indicated on Drawings, or comparable product by one of the following, or equal:
 - a. Acorn Engineering Co.

PART 3 - EXECUTION

3.1 PRODUCT HANDLING AND PROTECTION

- A. Deliver packaged materials in their original, unopened wrapping with labels intact. Protect materials from water, the elements and other damage during delivery, storage and handling.

3.2 PREPARATORY PROVISIONS

- A. The Contractor is responsible for the examination and acceptance of all conditions affecting the proper construction and/or installation of the Work of this Section. Do not proceed until all unsatisfactory conditions have been corrected. Commencing work will be construed as acceptance of all conditions by the Contractor as satisfactory for the construction and/or installation of the Work.

3.3 INSPECTION AND PREPARATION

- A. Examine roughing-in work of domestic water and waste piping systems to verify actual locations of piping connections prior to installing fixtures. Also examine floors and substrates, and conditions under which fixture work is to be accomplished. Correct any incorrect locations of piping, and other unsatisfactory conditions for installation of plumbing fixtures. Do not proceed with work until unsatisfactory conditions have been corrected.
- B. Install plumbing fixtures of types indicated where shown and at indicated heights; in accordance with fixture manufacturer's written instructions, roughing-in drawings. Ensure that plumbing fixtures comply with requirements and serve intended purposes. Comply with applicable requirements of the National Standard Plumbing Code pertaining to installation of plumbing fixtures.
- C. Fasten plumbing fixtures securely to supports or building structure; and ensure that fixtures are level and plumb. Secure plumbing supplies to blocking behind or within wall construction so as to be rigid, and not subject to pull or push movement.
- D. Install CBC accessible fixtures in accordance with Chapter 4 California Plumbing Code, and Chapters 11A and 11B California Building Code.
- E. Refer to Division 26 for wiring for electronic flush valves.

3.4 FAUCET INSTALLATION

- A. Provide 85 percent IPS red brass pipe, conforming to lead-free requirements of California Health and Safety Code Section 11 68 75, securely anchored to building construction, for each connection to faucets, stops, hose bibbs, etc. Each fixture, except hose bibbs, shall have a stop valve installed on water supply lines to permit repairs without shutting off water mains.

- B. Adjust metering faucets to run for 10 to 15 seconds.

3.5 CLEAN AND PROTECT

- A. Clean plumbing fixtures of dirt and debris upon completion of installation.
- B. Protect installed fixtures from damage during the remainder of the construction period.
- C. Grout voids between all fixtures and adjacent surfaces with white Dow Silicone Sealant, arranged to shed water.

3.6 FIELD QUALITY CONTROL

- A. Upon completion of installation of plumbing fixtures and after units are water pressurized, test fixtures to demonstrate capability and compliance with requirements. When possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units and proceed with retesting.

3.7 EXTRA STOCK

- A. General: Furnish special wrenches and other devices necessary for servicing plumbing fixtures and trim to Owner with receipt. Furnish one device for every ten units.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. SECTION INCLUDES
 - 1. Gas fired water heaters.
 - 2. Expansion tanks.
 - 3. In-line domestic hot water recirculation pumps.
 - 4. Neutralizing basin.
 - 5. Concrete grease interceptors.

1.2 RELATED REQUIREMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 22 00 50 Basic Plumbing Materials and Methods.

1.3 ACTION SUBMITTALS

- A. For additional requirements, refer to Section 22 00 50, Basic Plumbing Materials and Methods.
- B. Product Data: Submit manufacturer's plumbing equipment specifications, installation and start-up instructions, capacity and ratings, with selection points clearly indicated.

1.4 INFORMATIONAL SUBMITTALS

- A. For additional requirements, refer to Section 22 00 50, Basic Plumbing Materials and Methods.

1.5 CLOSEOUT SUBMITTALS

- A. For additional requirements, refer to Section 22 00 50, Basic Plumbing Materials and Methods.
- B. Maintenance Data: Submit maintenance data and parts lists for each item of plumbing equipment. Include "trouble-shooting" maintenance guides. Include this data in Operation and Maintenance Manual.

1.6 QUALITY ASSURANCE

- A. For additional requirements, refer to Section 22 00 50, Basic Plumbing Materials and Methods.
- B. Trade names or catalog numbers stated herein indicates grade or quality of materials desired.
- C. Dimensions, sizes, and capacities shown are minimum and shall not be changed without permission of Architect.

- D. UL and NEMA Compliance: Provide electric motors and electrical components required as part of plumbing equipment, which have been listed and labeled by Underwriters Laboratories and comply with NEMA standards.
- E. CEC Compliance: Comply with California Electrical Code (Title 24, Part 3) as applicable to installation and electrical connections of ancillary electrical components of plumbing equipment.
- F. ANSI Compliance: Comply with ANSI Z223.1 (NFPA 54) "National Fuel Gas Code", as applicable to installation of gas-fired water heaters.
- G. CSA/UL Labels:
 - 1. Provide gas-fired water heaters that have been listed and labeled by CSA International or Underwriters Laboratories, certifying design according to ANSI Z21.10.1-CSA 4.1 standards governing storage-type water heaters with input ratings of 75,000 BTU/hr. or less.
 - 2. Provide gas-fired water heaters that have been listed and labeled by CSA International or Underwriters Laboratories, certifying design according to ANSI Z21.10.3-CSA 4.3 standards governing storage-type water heaters with input ratings of greater than 75,000 BTU/hr.
- H. ASME Relief Valve Stamps: Provide water heaters with safety relief valves bearing ASME valve markings.
- I. ASME Code Symbol Stamps: For the following equipment, comply with ASME Boiler and Pressure Vessel Code for construction, and stamp with ASME Code symbol:
 - 1. Water Heaters 200 MBH and greater.
- J. California Energy Commission Compliance: Provide written confirmation of listing of all water heaters in the "Appliance Efficiency Database."

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver packaged materials in their original, unopened wrapping with labels intact. Protect materials from water, the elements and other damage during delivery, storage and handling.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 and NSF 372.
- B. Insulation products, including insulation, insulation facings, jackets, adhesives, sealants and coatings shall not contain polybrominated diphenyl ethers (PBDEs) in penta, octa, or deca formulations in amounts greater than 0.1 percent (by mass).

2.2 GAS FIRED WATER HEATERS

- A. General: All units shall comply with the emissions requirements of the Air Quality Management District (AQMD) in which they are to be installed.
- B. Power Gas Fired Water Heaters:

1. General: Provide commercial power gas-fired water heater of size, capacity, and electrical characteristics as noted on Drawings. Comply with ASHRAE 90.1 for energy efficiency. Provide UL or CSA International listing. Units with gas input above 200 MBH shall be ASME constructed and listed, stamped for 125 PSIG.
 2. Heater: Working pressure of 150 psi, magnesium anode rod, glass lining on internal surfaces exposed to water.
 3. Jacket: Insulate tank with vermin-proof glass fiber or polyurethane foam insulation. Provide heavy-gauge steel jacket and baked enamel finish.
 4. Warranty: Furnish three-year minimum limited warranty on tank.
 5. Accessories: Provide brass drain valve and 3/4 inch temperature and pressure relief valve. Provide thermometer, installed in the top 1/3 of the tank or at hot water discharge at the tank.
 6. Provide equal flow manifold for piping entering and leaving the water heaters. Manifold shall be provided as a standard option for the heaters proposed.
 7. Controls: Adjustable immersion thermostat with safety shutoff.
 8. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - a. Bradford White Corporation.
 - b. Lochinvar Corporation.
 - c. PVI Industries, LLC.
 - d. Rheem Manufacturing Company.
 - e. Smith, A.O. Water Products Co.; a division of A.O. Smith Corporation.
 9. Vent: Furnish and install "Metalbestos", Selkirk, or equal, Model PS, all-steel vent, UL listed. Furnish complete with roof support, flashing, Briedert, Metalbestos, or equal, Type L stainless stack cap, .035" stainless steel inner pipe, and all supports and accessories required for a complete installation. All joints shall be sealed with silicone sealant as recommended by the manufacturer for pressure-tight joints.
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - 1) American Metal Products
 - 2) Selkirk
 - 3) Metalbestos
- C. Direct Vented Sealed Combustion Condensing Gas-Fired Water Heater:
1. General: Provide commercial direct vented sealed combustion condensing gas-fired water heater of size, capacity, and electrical characteristics as noted on Drawings. Provide UL or CSA International listing. Design unit to conform to the following:
 - a. ASHRAE/IESNA 90.1.
 - b. California NOx emission requirements.
 - c. Units with gas input above 200 MBH shall be ASME constructed and listed, stamped for 150 PSIG.
 - d. Minimum efficiency of 95 percent.
 2. Storage Tank Construction: Seamless steel with 150 psig working-pressure rating, glass lining on internal surfaces exposed to water.
 3. Factory-Installed Storage Tank Appurtenances:
 - a. Anode Rods: Magnesium.
 - b. Jacket: Heavy-gauge steel with enameled finish.
 - c. Cleanout: Hand-hole cleanout through tank and jacket.
 - d. Burner: Low NOx, pre-mix powered type, down-fired configuration.
 - e. Insulation: Non-CFC foam.
 - f. Drain Valve: Brass construction.
 - g. Heat Exchanger Coil: Located within submerged combustion chamber.
 - h. Combination Temperature and Pressure Relief Valve.
 - i. Dielectric Fittings.

4. Warranty: Furnish three-year minimum limited warranty on tank.
5. Accessories: Provide thermometer, installed in the top 1/3 of the tank or at hot water discharge at the tank.
6. Controls: Adjustable electronic immersion thermostat with safety shutoff.
7. Condensate Drain Piping: CPVC piping as defined in Section 22 10 00.
8. Vent and Exhaust Piping: CPVC piping as defined in Section 22 10 00
9. See equipment Schedule and details on Drawings for additional accessories and requirements.
10. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - a. Bradford White Corporation.
 - b. Lochinvar Corporation.
 - c. PVI Industries, LLC.
 - d. Rheem Manufacturing Company.
 - e. Smith, A.O. Water Products Co.; a division of A.O. Smith Corporation.

2.3 EXPANSION TANKS

- A. Provide thermal expansion tanks of size and number as indicated on Drawings, conforming to lead-free requirements of California Health and Safety Code Section 11 68 75. Construct tank of welded steel for working pressure of 125 psi. Provide specially compounded flexible diaphragm securely sealed into tank to permanently separate air charge from system water, to maintain design expansion capacity.
 1. Tanks shall be IAPMO approved and listed for use with domestic water systems.
- B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 1. Amtrol, Inc.
 2. A.O. Smith Water Products Company.
 3. Watts Water Technologies, Inc.

2.4 IN-LINE DOMESTIC HOT WATER RECIRCULATION PUMPS

- A. Provide lead-free in-line domestic water recirculation pumps where indicated on Drawings and of capacities as scheduled on Drawings. Pumps shall be third-party certified by an approved laboratory as complying with California Health and Safety Code Section 11 68 75.
- B. Pumps shall be of the centrifugal type with non-overloading characteristics and shall not overload the motor above its nameplate horsepower rating under any operating condition. No allowance for service factor shall be used in pump selection. Motor horsepower shown is minimum; furnish larger motors if necessary to meet the non-overloading requirements.
- C. Type: Horizontal, designed for 125 thru 150 psi maximum working pressure and 225 degrees F continuous water temperature.
- D. Construction: Bronze casing, non-metallic impeller.
- E. Shaft: Ceramic, supported by carbon bearings. Bearings shall be lubricated by the pumped water.
- F. Motors shall have permanently lubricated ball bearings. Motors shall meet NEMA specifications. Motors shall have built-in thermal overload or impedance protection.

- G. Provide control wiring between field-installed controls, indicating devices, and pump control panels as work of this section, complying with requirements of Division 26 sections:
 - 1. Control wiring specified as work of Division 23 for Automatic Temperature Controls is work of that section.
- H. Wire pumps to mechanical control circuits to shut down pump when building is not occupied. Where no control system is installed, furnish pump manufacturers standard timer to automatically turn off circulating pump when hot water is not required.
- I. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - 1. Grundfos Pumps Corporation.
 - 2. Bell & Gossett, ITT Corporation.
 - 3. Taco Incorporated.
 - 4. Armstrong Pumps, Inc.

2.5 NEUTRALIZING BASINS

- A. Furnish and install, where shown and as detailed on the Drawings, a neutralizing basin complete with cover and manhole, and 4 inch vent connection. Cover and manhole shall be bolted and gasketed gas tight.
- B. Furnish sufficient limestone or marble chips in chunks 1 inch to 3 inches in size to fill the tank to within 2 inches of the outlet. Place this material in the tank at the completion of the work.

2.6 CONCRETE GREASE INTERCEPTORS

- A. Furnish and install a concrete grease interceptor with minimum capacity as indicated on the drawings, complete as cataloged. Provide manholes to grade for access to each section. Provide gastight cast-iron ring and cover at grade for each manhole.
- B. Provide concrete with an approved coating inside and outside.
- C. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - 1. M.C. Nottingham Company.
 - 2. Jensen Precast.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. The Contractor shall be responsible for the examination and acceptance of all conditions affecting the proper construction and/or installation of the Work of this Section and shall not proceed until all unsatisfactory conditions have been corrected. Commencing work shall be construed as acceptance of all conditions by the Contractor as satisfactory for the construction and/or installation of the Work.

3.2 GAS-FIRED WATER HEATER INSTALLATION

- A. Install gas-fired water heaters as indicated, in accordance with manufacturer's installation instructions and in compliance with applicable codes.

- B. Furnish wiring diagram to Electrical Installer. Refer to Division 26 for wiring of units, not work of this section.
- C. Connect to hot and cold water lines with shutoff valves and dielectric unions. Install ASME standard pressure and temperature relief valve. Connect drain and relief piping as noted on Drawings.
- D. Start-up, test, and adjust water heaters in accordance with manufacturer's start-up instructions. Check and calibrate controls.
- E. Install thermometer, in the top 1/3 of the tank or at hot water discharge at the tank.
- F. Confirm that water heater proposed is suitably equipped to be brought into the building through building openings provided, and that heater may be installed and removed through building openings provided.
- G. Additional requirements for direct vented sealed combustion condensing water heaters:
 - 1. Install vent and exhaust piping for direct vented sealed combustion condensing gas-fired water heaters strictly in accordance with unit manufacturers' recommendations.
 - 2. Trap condensate drain line per manufacturers' recommendations and run to nearest code-compliant point of disposal.

3.3 PUMP INSTALLATION

- A. Install pumps where indicated, in accordance with manufacturer's published instructions, complying with recognized industry practices to ensure that pumps comply with requirements and serve intended purposes.
- B. Provide access space around pumps for service as indicated, but in no case less than that recommended by manufacturer.
- C. Install in-line pumps with support from overhead structure on each side of pump, or as indicated on Drawings.
- D. Support piping from the building structure so as to prevent any strain on the pump casings. Provide a final check for perfect alignment of the piping connections after pump has been secured to its base. Provide valves, accessories, gauges, flexible connections, and supports as indicated.
- E. Install electrical devices furnished by manufacturer but not specified to be factory mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.
- F. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 sections. Do not proceed with equipment start-up until wiring installation is complete and correct.
- G. Check alignment, and where necessary, realign shafts of motors and pumps within recommended tolerances by manufacturer.
- H. Lubricate pumps before start-up. Start-up in accordance with manufacturer's instructions.
- I. Increase piping immediately at pump suction and discharge; flexible couplings and all valves shall be full line size.

- J. Trim pump impeller to obtain the desired water flow after installation, without cost to Owner.
- K. Pumps shall not be connected to piping before piping is thoroughly flushed and cleaned of all dirt and grit. After piping connections have been made, systems shall be filled before starting pumps. Pumps shall not be run dry under any circumstances.

3.4 INTERCEPTOR INSTALLATION

- A. Install interceptors as indicated, in accordance with manufacturer's installation instructions and in compliance with applicable codes.
- B. Support: Anchor interceptors securely to substrate. Locate interceptors so that adequate clearance is provided to remove covers and sediment baskets. Set recessed units so top of cover is flush with finished grade.
- C. Piping: Connect inlet and outlet piping to interceptors.
- D. Refer to local standards for special installation requirements.

3.5 DEMONSTRATION AND TRAINING

- A. Provide a minimum of 8 hours of training and orientation of Owners staff in proper care and operation of Plumbing Equipment.

3.6 CARE AND CLEANING

- A. Repair or replace broken, damaged, or otherwise defective parts, materials, and work. Leave entire work in condition satisfactory to Architect. At completion, carefully clean and adjust equipment, fixtures, and trim that are installed as part of this work. Leave systems and equipment in satisfactory operating condition.

3.7 OPERATIONAL TESTS

- A. Test each piece of equipment to show that it will operate in accordance with indicated requirements.

3.8 CLEANING UP

- A. Upon completion of Work remove materials, equipment, apparatus, tools, and the like, and leave premises clean, neat, and orderly.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Electric motors.
 - 2. Motor starters.
 - 3. Strainers.
 - 4. Valve boxes.
 - 5. Gauges.
 - 6. Thermometers.
 - 7. Access Doors.
 - 8. Expansion loops.
 - 9. Flexible joints.
 - 10. Insulation.

1.2 RELATED REQUIREMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. This Section is a part of each Division 23 Section.

1.3 ADDITIONAL REQUIREMENTS

- A. Furnish and install incidental work not shown or specified necessary to provide a complete and workable system.
- B. Make all temporary connections required to maintain services, including adequate heat and cooling, during the course of the Contract without additional cost to Owner. Notify Owner seven days in advance before disrupting services.
- C. Provide for adjustments or modifications to fan and motor sheaves, belts, damper linkages, and other components as required to achieve specified air balance at no additional cost to Owner.

1.4 REFERENCES AND STANDARDS

- A. Where material or equipment is specified to conform to referenced standards, it shall be assumed that the most recent edition of the standard in effect at the time of bid shall be used.
 - 1. AABC - Associated Air Balance Council
 - 2. AFBMA - Anti Friction Bearing Manufacturer's Association
 - 3. AMCA - Air Moving and Control Association Inc.
 - a. Standard 210 - Laboratory Methods of Testing Fans
 - 4. ANSI - American National Standards Institute
 - 5. ARI - Air-Conditioning and Refrigeration Institute
 - 6. ASHRAE - American Society of Heating, Refrigerating and Air Conditioning Engineers
 - 7. ASME - American Society of Mechanical Engineers
 - 8. ASTM - American Society for Testing and Materials
 - 9. CCR - California Code of Regulations
 - a. Title 8 - Division of Industrial Safety, Subchapter 7; General Industry Safety Orders, Articles 31 through 36

10. CSA – Canadian Standards Association International
11. CSFM - California State Fire Marshal
12. NCPWB - National Certified Pipe Welding Bureau
13. NIST - National Institute of Standards and Technology
14. NEMA - National Electrical Manufacturers' Association
15. NFPA - National Fire Protection Association
16. OSHA - Occupational Safety and Health Act
17. SMACNA - Duct Manuals
18. UL - Underwriters' Laboratories, Inc.

B. Requirements of Regulatory Agencies:

1. The publications listed below form part of this specification; comply with provisions of these publications except as otherwise shown or specified.
 - a. California Building Code, 2019.
 - b. California Electrical Code, 2019.
 - c. California Energy Code, 2019.
 - d. California Fire Code, 2019.
 - e. California Green Building Standards Code, 2019.
 - f. California Mechanical Code, 2019.
 - g. California Plumbing Code, 2019.
 - h. California Code of Regulations, Title 24.
 - i. California Health and Safety Code.
 - j. CAL-OSHA.
 - k. California State Fire Marshal, Title 19 CCR.
 - l. National Fire Protection Association.
 - m. Occupational Safety and Health Administration.
 - n. Other applicable state laws.
2. Nothing in Drawings or specifications shall be construed to permit work not conforming to these codes, or to requirements of authorities having jurisdiction. It is not the intent of Drawings or specifications to repeat requirements of codes except where necessary for clarity.

1.5 DRAWINGS

- A. Examine Drawings prior to bidding of work and report discrepancies in writing to Architect.
- B. Drawings showing location of equipment and materials are diagrammatic and job conditions will not always permit installation in location shown. The HVAC Drawings show general arrangement of equipment and materials, etc., and shall be followed as closely as existing conditions, actual building construction, and work of other trades permit.
 1. Architectural and Structural Drawings shall be considered part of the Work. These Drawings furnish Contractor with information relating to design and construction of the Project. Architectural Drawings take precedence over HVAC Drawings.
 2. Because of the small scale of HVAC Drawings, not all offsets, fittings, and accessories required are shown. Investigate structural and finish conditions affecting the Work and arrange Work accordingly. Provide offsets, fittings, and accessories required to meet conditions. Inform Architect immediately when job conditions do not permit installation of equipment and materials in the locations shown. Obtain the Architects approval prior to relocation of equipment and materials.
 3. Relocate equipment and materials installed without prior approval of the Architect. Remove and relocate equipment and materials at Contactors' expense upon Architects' direction.

4. Minor changes in locations of equipment, piping, ducts, etc., from locations shown shall be made when directed by the Architect at no additional cost to the Owner providing such change is ordered before such items of work, or work directly connected to same are installed and providing no additional material is required.
- C. Execute work mentioned in the Specifications and not shown on the Drawings, or vice versa, the same as if specifically mentioned or shown in both.

1.6 FEES AND PERMITS

- A. Obtain and pay for permits and service required in installation of the Work. Arrange for required inspections and secure approvals from authorities having jurisdiction. Comply with requirements of Division 01.
- B. Arrange for utility connections and pay charges incurred, including excess service charges.
- C. Coordination:
 1. General:
 - a. Coordinate HVAC Work with trades covered in other Specifications Sections to provide a complete, operable and sanitary installation of the highest quality workmanship.
 2. Have fire damper and fire smoke damper installation instructions available at Project site during construction for use by Project Inspector.
 3. Electrical Coordination:
 - a. Refer to the Electrical Drawings and Specifications, Division 26, for service voltage and power feed wiring for equipment specified under this section. Contractor has full responsibility for the following items of work:
 - 1) Review the Electrical Drawings and Division 26 Specifications to verify that electrical services provided are adequate and compatible with equipment requirements.
 - 2) If additional electrical services are required above that indicated on Electrical Drawings and in Division 26, such as more control interlock conductors, larger feeder, or separate 120 volt control power source, include cost to furnish and install additional electrical services as part of the bid.
 - 3) Prior to proceeding with installation of additional electrical work, submit detailed drawings indicating exact scope of additional electrical work.
 4. Mechanical Coordination:
 - a. Arrange for pipe spaces, chases, slots and openings in building structure during progress of construction, to accommodate mechanical system installation.
 - b. Coordinate installation of supporting devices. Set sleeves in poured-in-place concrete and other structural components during construction.
 - c. Coordinate requirements for access panels and doors for mechanical items requiring access where concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."
 - d. Coordinate with other trades equipment locations, pipe, duct and conduit runs, electrical outlets and fixtures, air inlets and outlets, and structural and architectural features. Provide information on location of piping and seismic bracing to other trades as required for a completely coordinated project.

1.7 SUBMITTALS - GENERAL

- A. Refer to Division 01 Submittals Section(s) for additional requirements.

- B. Submittal packages may be submitted via email as PDF electronic files, or as printed packages. PDFs shall be legible at actual size (100 percent). Provide seven copies of printed submittal packages.

- C. Provide submittal of materials proposed for use as part of this Project. Product names in Specifications and on Drawings are used as standards of quality. Furnish standard items on specified equipment at no extra cost to the Contract regardless of disposition of submittal data. Other materials or methods shall not be used unless approved in writing by Architect. Architect's review will be required even though "or equal" or synonymous terms are used.
 - 1. Partial or incomplete submittals will not be considered.
 - 2. Quantities are Contractor's responsibility and will not be reviewed.
 - 3. Provide materials of the same brand or manufacturer for each class of equipment or material.
 - 4. Identify each item by manufacturer, brand, trade name, number, size, rating, or other data necessary to properly identify and review materials and equipment. Words "as specified" are not sufficient identification.
 - 5. Identify each submittal item by reference to items' Specification Section number and paragraph, by Drawing and detail number, and by unit tag number.
 - 6. Organize submittals in same sequence as in Specification Sections.
 - 7. Show physical arrangement, construction details, finishes, materials used in fabrications, provisions for piping entrance, access requirements for installation and maintenance, physical size, mechanical characteristics, foundation and support details, and weight.
 - a. Submit Shop Drawings, performance curves, and other pertinent data, showing size and capacity of proposed materials.
 - b. Specifically indicate, by drawn detail or note, that equipment complies with each specifically stated requirement of Contract Documents.
 - c. Drawings shall be drawn to scale and dimensioned (except schematic diagrams). Drawings may be prepared by vendor but must be submitted as instruments of Contractor, thoroughly checked and signed by Contractor before submission to Architect for review.
 - d. Catalog cuts and published material may be included with supplemental scaled drawings.

- D. Review of submittals will be only for general conformance with design concept and general compliance with information given in Contract Documents. Review will not include quantities, dimensions, weights or gauges, fabrication processes, construction methods, coordination with work of other trades, or construction safety precautions, which are sole responsibility of Contractor. Review of a component of an assembly does not indicate acceptance of an assembly. Deviations from Contract Documents not clearly identified by Contractor are Contractor's responsibility and will not be reviewed by Architect.

- E. Within reasonable time after award of contract and in ample time to avoid delay of construction, submit to Architect shop drawings or submittals on all items of equipment and materials provided. Provide submittal as a complete package.
 - 1. Shop drawings and submittals shall include Specification Section, Paragraph number, and Drawing unit symbol or detail number for reference. Organize submittals into booklets for each Specification section and submit in loose-leaf binders with index. Deviations from the Contract Documents shall be prominently displayed in the front of the submittal package and referenced to the applicable Contract requirement.

- F. Furnish to the Project Inspector complete installation instructions on material and equipment before starting installation.

1.8 ACTION SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for plumbing systems materials and products.
- B. Shop Drawings.
- C. Provide product data for insulation products, including insulation, insulation facings, jackets, adhesives, sealants, and coatings, indicating compliance with requirement that these products contain less than 0.1 percent (by mass) polybrominated diphenyl ethers (PBDEs) in penta, octa, or deca formulations.
- D. Delegated-Design Submittals: For seismic supports, anchorages, restraints, and vibration isolators indicated to comply with performance requirements and design criteria.
 - 1. Calculations performed for use in selection of seismic supports, anchorages, restraints, and vibration isolators shall utilize criteria indicated in Structural Contract Documents.
 - 2. Include design calculations and details for selecting vibration isolators and vibration isolation bases complying with performance requirements, design criteria, and analysis data signed and sealed by the California registered structural engineer responsible for their preparation.
 - 3. Supports, anchorage and restraints for piping, ductwork, and equipment shall be an OSHPD pre-approved system such as TOLCO, ISAT, Mason, or equal. Pipes, ducts and equipment shall be seismically restrained in accordance with requirements of current edition of California Building Code. System shall have current OPM number and shall meet additional requirements of authority having jurisdiction. Provide supporting documentation required by the reviewing authority and the Architect and Engineer. Provide layout drawings showing piping, ductwork and restraint locations.
 - a. Bracing of Piping, Ductwork, and Equipment: Specifically state how bracing attachment to structure is accomplished. Provide shop drawings indicating seismic restraints, including details of anchorage to building. In-line equipment must be braced independently of piping and ductwork, and in conformance with applicable building codes. Provide calculations to show that pre-approval numbers have been correctly applied in accordance with general information notes of pre-approval documentation.
 - b. In lieu of the above or for non-standard installations not covered in the above pre-approved systems, Contractor shall provide layout drawings showing piping, ductwork, and restraint locations, and detail supports, attachments and restraints, and furnish supporting calculations and legible details sealed by a California registered structural engineer, in accordance with 2019 California Building Code
 - 4. Additional Requirements: In addition to the above, conform to all state and local requirements.

1.9 INFORMATIONAL SUBMITTALS

- A. Provide coordinated layouts for HVAC Ductwork systems, in accordance with Specification Section 23 80 00.
- B. Provide evidence of equipment certification to California Energy Code Section 110.1 or 110.2, if not providing Electrically Commutated motors for HVAC fans sized below 1 hp and above 1/12 hp. Refer to specific equipment articles requiring electrically commutated motors.
- C. Check, Test, and Start forms, from equipment manufacturers.
- D. Check, Test and Start reports.

1.10 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data:
 - 1. Furnish three complete sets of Operation and Maintenance Manual bound in hardboard binder, and one compact disc containing complete Operation and Maintenance Manual in searchable PDF format. Provide Table of Contents. Provide index tabs for each piece of equipment in binder and disc. Begin compiling data upon approval of submittals.
 - a. Sets shall incorporate the following:
 - 1) Product Data.
 - 2) Shop Drawings.
 - 3) Record Drawings.
 - 4) Service telephone number, address and contact person for each category of equipment or system.
 - 5) Complete operating instructions for each item of heating, ventilating and air conditioning equipment.
 - 6) Copies of guarantees/warranties for each item of equipment or systems.
 - 7) Test data and system balancing reports.
 - 8) Typewritten maintenance instructions for each item of equipment listing lubricants to be used, frequency of lubrication, inspections required, adjustment, etc.
 - 9) Manufacturers' bulletins with parts numbers, instructions, etc., for each item of equipment.
 - 10) Temperature control diagrams and literature.
 - 11) Check test and start reports for each piece of mechanical equipment provided as part of the Work.
 - 12) Commissioning and Preliminary Operation Tests required as part of the Work.
 - 2. Post service telephone numbers and addresses in an appropriate place designated by Architect.
- B. Record Drawings:
 - 1. Refer to Division 01 for additional requirements.
 - 2. Upon completion of the Work, deliver to Architect the following:
 - a. Originals of drawings showing the Work exactly as installed.
 - b. One complete set of reproducible drawings showing the Work exactly as installed.
 - c. One compact disc with complete set of drawings in PDF format showing the Work exactly as installed.
 - d. Provide Contractor's signature, verifying accuracy of record drawings.
 - e. Obtain the signature of the Inspector of Record for Record Drawings.

1.11 SUBSTITUTIONS

- A. Refer to Division 01 for complete instructions. Requirements given below are in addition to or are intended to amplify Division 01 requirements. In case of conflict between requirements given herein and those of Division 01, Division 01 requirements shall apply.
- B. It is the responsibility of Contractor to assume costs incurred because of additional work and or changes required to incorporate proposed substitute into the Project. Refer to Division 01 for complete instructions.
- C. Substitutions will be interpreted to be manufacturers other than those specifically listed in the Contract Documents by brand name, model, or catalog number.
- D. Only one request for substitution will be considered for each item of equipment or material.

- E. Substitution requests shall include the following:
 - 1. Reason for substitution request.
 - 2. Complete submittal information as described herein; see "Submittals."
 - 3. Coordinated scale layout drawings depicting position of substituted equipment in relation to other work, with required clearances for operation, maintenance and replacement.
 - 4. List optional features required for substituted equipment to meet functional requirements of the system as indicated in Contract Documents.
 - 5. Explanation of impact on connected utilities.
 - 6. Explanation of impact on structural supports.
- F. Installation of reviewed substitution is Contractors' responsibility. Any mechanical, electrical, structural, or other changes required for installation of substituted equipment or material must be made by Contractor without additional cost to Owner. Review by Architect of substituted equipment or material, will not waive these requirements.
- G. Contractor may be required to compensate Architect for costs related to substituted equipment or material.

1.12 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of HVAC systems products, of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Contractor's Qualifications: Firm with at least 5 years of successful installation experience on projects with HVAC systems work similar to that required for this Project.
- C. Comply with applicable portions of California Mechanical Code pertaining to selection and installation of HVAC materials and products.
- D. All materials and products shall be new.

1.13 DELIVERY, STORAGE, AND HANDLING

- A. Protect equipment and materials delivered to Project site from weather, humidity and temperature variations, dirt, dust and other contaminants.

1.14 FIELD CONDITIONS

- A. Contractor shall visit Project site and examine existing conditions in order to become familiar with Project scope. Verify dimensions shown on Drawings at Project site. Bring discrepancies to the attention of Architect. Failure to examine Project site shall not constitute basis for claims for additional work because of lack of knowledge or location of hidden conditions that affect Project scope.
- B. Information on Drawings relative to existing conditions is approximate. Deviations from Drawings necessary during progress of construction to conform to actual conditions shall be approved by the Architect and shall be made without additional cost to the Owner. The Contractor shall be held responsible for damage caused to existing services. Promptly notify the Architect if services are found which are not shown on Drawings.

1.15 WARRANTY

- A. Refer to Division 01 for warranty requirements, including effective date of warranty. Refer to specific items of equipment specified herein for warranty duration if different from that specified in Division 01.
- B. Repair or replace defective work, material, or part that appears within the warranty period, including damage caused by leaks.
- C. On failure to comply with warranty requirements within a reasonable length of time after notification is given, Architect/Owner shall have repairs made at Contractor's expense.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Materials or equipment of the same type shall be of the same brand wherever possible. All materials shall be new and in first class condition.
- B. All sizes, capacities, and efficiency ratings shown are minimum, except that gas capacity is maximum available.
- C. Refer to Division 22 10 00 and 23 80 00 for specific system piping materials.

2.2 MATERIALS

- A. No material installed as part of this Work shall contain asbestos.
- B. Insulation products, including insulation, insulation facings, jackets, adhesives, sealants and coatings shall not contain polybrominated diphenyl ethers (PBDEs) in penta, octa, or deca formulations in amounts greater than 0.1 percent (by mass).
- C. California Green Building Code Compliance:
 - 1. HVAC and refrigeration equipment shall not contain CFCs.
 - 2. HVAC and refrigeration equipment shall not contain Halons.

2.3 ELECTRIC MOTORS

- A. General Motor Requirements: Comply with NEMA MG 1 unless otherwise indicated. Comply with IEEE 841 for severe-duty motors.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - a. U.S. Motors.
 - b. Century Electric.
 - c. General Electric.
 - d. Lincoln.
 - e. Gould.
- B. Motor Characteristics: Designed for continuous duty at ambient temperature of 40 deg. C and at altitude of 3300 feet above sea level. Capacity and torque shall be sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

1. Motors exceeding the nameplate amperage shall be promptly replaced at no cost to the Owner. Horsepower shown is minimum and shall be increased as necessary to comply with above requirements. Furnish motors with splash-proof or weatherproof housings, where required or recommended by the manufacturer. Match the nameplate voltage rating with the electrical service supplied. Check Electrical Drawings. Provide a transformer for each motor not wound specifically for system voltage.
- C. Polyphase Motors: NEMA MG 1, Design B, medium induction motor, premium efficiency as defined in NEMA MG 1. Select motors with service factor of 1.15. Provide motor with random-wound, squirrel cage rotor, and permanently lubricated or regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading. Temperature rise shall match insulation rating. Provide Class F insulation.
1. Multispeed motors shall have separate windings for each speed.
- D. Polyphase Motors with Additional Requirements:
1. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
 2. Motors Used with Variable Frequency Controllers:
 - a. Separately Connected Motors: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
 - b. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
 - c. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
 - d. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
 - e. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
 - f. Each motor shall be provided with a shaft grounding device for stray current protection.
 3. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.
- E. Single-Phase Motors:
1. Select motors with service factor of 1.15.
 2. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
 - a. Permanent-split capacitor.
 - b. Split phase.
 - c. Capacitor start, inductor run.
 - d. Capacitor start, capacitor run.
 3. Motors for HVAC exhaust, transfer, and supply fans larger than 1/12 hp and smaller than 1 hp shall be the following:
 - a. Electronically Commutated motor (EC type): Motor shall be electronically commutated type specifically designed for applications, with heavy duty ball bearings. The motor shall be speed controllable down to 20% of full speed and 85% efficient at all speeds.
 - 1) Exceptions:
 - a) Motors in fan-coils and terminal units that operate only when providing heating to the space served.
 - b) Motors installed in space conditioning equipment certified under 2013 California Energy Code Section 110.1 or 110.2.
 4. Contractor's Option: Motors scheduled on Drawings as single-phase, and larger than 1/12 hp and smaller than 1 hp, for applications other than HVAC fans, may be EC type.
 5. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

6. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
7. Motors 1/20 HP and Smaller: Shaded-pole type.
8. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

2.4 MOTOR STARTERS

- A. Square D, Allen Bradley, or equal, in NEMA Type 1 enclosure, unless otherwise specified or required. Minimum starter size shall be Size 1. Provide NEMA 3R enclosure where exposed to outdoors.
- B. Provide magnetic motor starters for all equipment provided under the Mechanical Work. Starters shall be non-combination type. Provide part winding or reduced voltage start motors where shown or as hereinafter specified. Minimum size starter shall be Size 1.
 1. All starters shall have the following:
 - a. Cover mounted hand-off-automatic switch. Starters installed exposed in occupied spaces shall have key operated HOA switch.
 - b. Ambient compensated thermal overload.
 - c. Fused control transformer (for 120 or 24 volt service).
 - d. Pilot lights, integral with the starters. Starters located outdoors shall be in NEMA IIIIR enclosures.
 2. Where three phase motors are provided for two-speed operation, provide two speed motor starters.
 3. Starters for single-phase motors shall have thermal overloads. NEMA I enclosure for starters located indoors, NEMA IIIIR enclosure for starters located outdoors.
 4. Provide OSHA label indicating the device starts automatically.

2.5 STRAINERS

- A. Charles M. Bailey #100A, Armstrong, Muessco, or equal, Fig. 11 "Y" pattern, 125 psi WP minimum, with monel screens with 20 square mesh for 2 inches and smaller and 3/64 inch perforations for 2-1/2 inches and larger. Install all strainers with a blow-off hose valve with hose adapter. Strainer shall have gasketed cover with straight thread.

2.6 VALVE BOXES

- A. General:
 1. Where several valves or other equipment are grouped together, provide larger boxes of rectangular "vault" type adequately sized for condition and similar in construction to those specified above.
 2. Provide valve box extensions as required to set bottom of valve box tight up to top of piping in which valve is installed.
 3. Provide a tee handle wrench for each size, Alhambra Foundry Co. #A-3008, or equal.
- B. Valve Boxes in Traffic Areas: Provide Christy No. G5 traffic valve box, Brooks, or approved equal, 10-3/8 inches inside diameter with extensions to suit conditions, with cast iron locking cover. Provide Owner with set of special wrenches or tools as required for operation of valves.

- C. Valve Boxes in Non-Traffic Areas: Provide Christy No. F22, Brooks, or approved equal, 8 inches inside diameter by 30 inches long, with cast iron locking cover. Provide Owner with set of special wrenches or tools as required for operation of valves. Cut bottom of plastic body for operation of valves.
- D. Valve Box (Rectangular Vault Type): Precast concrete or cast iron with cast iron locking type covers lettered to suit service – Brooks No. 3-TL, Christy No. B3, Fraser No. 3, Alhambra A-3004 or A-3005, Alhambra E-2202, or E-2702, or approved equal, with extension to suit conditions.

2.7 GAUGES

- A. Marsh "Series J", U.S. Gage, Danton 800, or equal, with bronze bushed movement and front recalibration. Dials shall be white with black numerals, 3-1/2 inch dial face. Normal reading shall be at mid-scale. Provide a needle valve on each gauge connection. Supply a gauge piped with branch isolation valves across the inlet and outlet of each pump and where shown on the Drawings.
- B. Provide Pete's Plug II, Sisco P/T, or equal, test plug with Nordel core {and gasketed cap}, on inlet and outlet of each coil, boiler, condenser, chiller and heat exchanger and where shown on Drawings.

2.8 THERMOMETERS

- A. Marsh, Taylor, Palmer, or equal, 5 inch diameter bimetal dial, adjustable from face, with adjustable positioner, located to be easily read from normal personnel approach. Normal reading shall be at mid-scale.
 - 1. Provide extension for insulation.
 - 2. Provide thermometers with steel bulb chambers and brass separable sockets.
 - 3. Thermometers for air temperature shall have 8 inch minimum stem.
- B. Provide Ventlock, Durodyne, or equal thermometer test holes at each air conditioning unit, furnace, and make-up air unit, in mixed air and supply air, and at all locations shown or scheduled on the Drawings. Provide two portable thermometers, with sensing connection arranged to suit test connections.
- C. Provide Pete's Plug II, Sisco P/T, or equal, test plug with Nordel core, on inlet and outlet of each coil, boiler, condenser, chiller and heat exchanger and provide two digital electronic test thermometers for each range of fluid temperature and where shown on Drawings.

2.9 ACCESS DOORS

- A. Where floors, walls, or ceilings must be penetrated for access to mechanical equipment, provide access doors, 14 inch by 14 inch minimum size in usable opening. Where entrance of a serviceman may be required, provide 20 inch by 30 inch minimum usable opening. Locate access doors/panels for non-obstructed and easy reach.
 - 1. All access doors less than 7'-0" above floors and exposed to public access shall have keyed locks.
- B. Access doors shall match those supplied in Division 08 in all respects, except as noted herein.

- C. Provide stainless steel access doors for use in toilet rooms, shower rooms, kitchens and other damp areas. Provide steel access doors with prime coat of baked-on paint for all other areas.
- D. Where panels are located on ducts or plenums, provide neoprene gaskets to prevent air leakage, and use frames to set door out to flush with insulation.
- E. Provide insulated doors where located in internally insulated ducts or casings.
- F. Do not locate access doors in highly visible public areas such as lobbies, waiting areas, and primary entrance areas. Coordinate with the Architect when access is required in these areas.
- G. Where specific information or details relating to access panels different from the above is shown or given on the Drawings or other Divisions of work, then that information shall supersede this specification.
- H. Manufacturers: Subject to compliance with requirements, available manufacturers offering products which may be incorporated into the Work include Milcor, Karp, Nystrom, or Cesco, equal to the following:
 - 1. Milcor
 - a. Style K (plaster).
 - b. Style DW (gypsum board).
 - c. Style M (Masonry).
 - d. Style "Fire Rated" where required.

2.10 EXPANSION LOOPS

- A. Manufactured assembly consisting of inlet and outlet elbow fittings, two sections of flexible metal hose and braid, and 180-degree return bend or center section of flexible hose. Flexible hose shall consist of corrugated metal inner hose and braided outer sheath. Provide assembly selected for 4 inches of movement.
- B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - 1. Metraflex Inc., Metraloop series.
 - 2. Unisource Manufacturing, Inc., V series.

2.11 FLEXIBLE JOINTS

- A. Where indicated on Drawings, provide Metraflex Metrasphere, Style R, Mason Industries, or equal, Spherical Expansion Joints. Provide control units at each expansion joint, arranged to limit both expansion and compression.
- B. Flexible joints at entry points to building shall be Barco Ductile iron, Advanced Thermal Systems, or equal, threaded style with stainless ball and mineral filled seal.

2.12 PIPE GUIDES

- A. Where flexible connections are indicated on Drawings, provide Metraflex style IV, B-Line, or equal, pipe guides in locations recommended by manufacturer. Maximum spacing from flexible connection to first pipe guide is 4 pipe diameters, and maximum spacing from second pipe guide is 14 pipe diameters.

2.13 EQUIPMENT IDENTIFICATION

- A. Identify each piece of equipment with a permanently attached engraved bakelite plate, 1/2 inch high white letters on black background.

2.14 PIPE IDENTIFICATION

- A. Identify each piping system and indicate the direction of flow by means of Seton, Inc., Marking Services Inc., Reef Industries, Inc., or equal, pre-tensioned, coiled semi-rigid plastic pipe labels formed to circumference of pipe, requiring no fasteners or adhesive for attachment to pipe.
- B. The legend and flow arrow shall conform to ASME A13.1.

2.15 INSULATION WORK

- A. General:
 - 1. Insulation products, including insulation, insulation facings, jackets, adhesives, sealants and coatings shall not contain polybrominated diphenyl ethers (PBDEs) in penta, octa, or deca formulations in amounts greater than 0.1 percent (by mass).
 - 2. Adhesives and sealants shall comply with testing and product requirements of South Coast Air Quality Management District, Rule 1168.
 - 3. The term "piping" used herein includes pipe, air separators, valves, strainers and fittings.
 - 4. Apply insulating cement to fittings, valves and strainers and trowel smooth to the thickness of adjacent covering. Cover with jacket to match piping. Extend covering on valves up to the bonnet. Leave strainer cleanout plugs accessible.
 - 5. Provide pre-formed PVC valve and fitting covers for indoor piping.
 - 6. Provide factory-fabricated aluminum valve and fitting covers for outdoor piping.
 - 7. Provide Calcium Silicate rigid insulation and sheet metal sleeve, 18 inch minimum length at each pipe hanger. Seal ends of insulation to make vapor tight with jacket.
 - 8. Test insulation, jackets, and lap-seal adhesives as a composite product and confirm flame spread of not more than 25 and a smoke developed rating of not more than 50 when tested in accordance with UL723, ASTM E84, or NFPA 255.
 - 9. Clean thoroughly, test and have approved, all piping and equipment before installing insulation and/or covering.
 - 10. Repair all damage to existing pipe and duct insulation whether or not caused during the work of this contract, to match existing adjacent insulation for thickness and finish, but conforming to flame spread and smoke ratings specified above.
- B. Insulation of Piping:
 - 1. Exposed insulated piping within the building shall have a Zeston 2000 25/50, Proto Lo-Smoke, or equal, PVC jacket and fitting cover installed over the insulation, applied per manufacturer's instructions. Insulation shall be vapor tight before applying PVC jacket and fitting covers. Verify suitability with manufacturer of insulation. Insulation with pre-applied polymer jacket may be substituted at Contractor's option.
 - 2. Insulate refrigerant suction piping and chilled water supply and return piping, including fittings, with minimum 3-1/2 pounds per cubic foot density fiberglass with factory-applied ASJ-SSL jacket. Insulate valves and irregular surfaces to match adjacent insulation and cover with two layers of Glasfab saturated in Foster's Sealfas 30-36, 3M, or equal, carried 3 inches over the adjoining pipe insulation. Finish with a coat of Foster's Sealfas 30-36, 3M, or equal. The 3 inch wide SSL end laps furnished with the insulation shall be adhered over the end joints. Seal entire surface of insulation vapor tight, including joints and ends of PVC or aluminum fitting covers. Insulation thicknesses per application follow:
 - a. Indoor refrigerant suction piping smaller than 1-1/2 inches diameter: 1/2 inch thick.

- b. Indoor refrigerant suction piping 1-1/2 inches diameter and larger: 1 inch thick.
 - c. Indoor refrigerant suction piping for heat pump applications smaller than 1 inch diameter: 1 inch thick.
 - d. Indoor refrigerant suction piping for heat pump applications 1 inch and larger: 1-1/2 inches thick.
 - e. Outdoor refrigerant suction piping; all sizes: 2 inches thick.
 3. In lieu of the above, refrigerant suction piping, including fittings, may be insulated with Armacell LLC; AP Armaflex, or equal. Seal all joints with Armaflex 520 BLV adhesive, or equal. Apply insulation in strict accordance with manufacturer's recommendations. Insulation thicknesses shall be as specified for fiberglass insulation.
 4. When equipment manufacturers' instructions indicate that refrigerant liquid and hot-gas piping be insulated, insulation thickness shall be equal to, and applied as described herein for refrigerant suction piping.
 5. Insulate indoor heating hot water piping with minimum 3-1/2 pounds per cubic foot density fiberglass, with factory applied ASJ-SSL jacket, 1-1/2 inches thick for pipes 1-1/4 inches and smaller, 2 inches thick for pipes 1-1/2 inches and larger. Insulate outdoor heating hot water piping with minimum 3-1/2 pounds per cubic foot density fiberglass, with factory applied ASJ-SSL jacket, 2 inches thick for all pipe sizes.
 6. Where insulated piping is exposed to the weather apply aluminum jacket secured with 1/2 inch stainless-steel bands on 12 inch centers. Insulation shall be vapor tight before applying metal jacket, and aluminum fitting covers. Install jacketing with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Cover fittings with glass cloth, two coats of Foster Sealfas 30-36, and factory-fabricated aluminum fitting covers, of same material, finish, and thickness as jacket. Insulation shall be vapor tight before applying metal jacket and fitting covers.
 - a. Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - b. Tee covers.
 - c. Flange and union covers.
 - d. End caps.
 - e. Beveled collars.
 - f. Valve covers.
 - g. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
 7. Jacket thickness:
 - a. Pipes 10 inches diameter and smaller: Minimum .016 inch thick jacket with smooth finish.
 - b. Pipes 12 inches diameter and larger: Minimum .020 inch thick jacket with smooth finish.
- C. Duct Insulation:
1. Duct insulation shall meet minimum R-value of R-8 at 3 inch thickness 3/4 pound per cubic foot density for ductwork installed outside the building insulation envelope. Ductwork installed within the building insulation envelope, duct insulation shall have a minimum R-value of R-4.2 at 2 inch thickness, 3/4 pound per cubic foot density.
 2. General: Insulation applied to the exterior surface of ducts located in buildings shall have a flame spread of not more than 25 and a smoke-developed rating of not more than 50 when tested as a composite installation including insulation, facing materials, tapes and adhesives as normally applied. Material exposed within ducts or plenum shall have a flame-spread rating of not more than 25 and a smoke-developed rating of not more than 50.
 3. Fibrous Glass Blanket Insulation:

- a. Insulate all unlined concealed supply and return ducts with fiberglass duct wrap, manufactured as a blanket of glass fibers factory laminated to a reinforced foil/kraft vapor retarding facing. Provide 2 inch stapling and taping flange. Wrap insulation entirely around duct and secure with outward clinching staples on 6 inch centers. Provide mechanical fasteners at maximum 18 inch centers for all bottoms of duct which are greater than 24 inches. Lap all insulation joints 3" minimum. Insulate ducts installed tight against other work before hanging in place. Seal all seams, both longitudinal and transverse, and all staple and mechanical fastener penetrations of facing with scrim backed foil tape or recommended sealant, to provide a vapor tight installation.
4. Fibrous Glass Board Insulation:
 - a. Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied FSK jacket.
5. Provide internal duct lining in accordance with specification section 23 80 00.

PART 3 - EXECUTION

3.1 EXISTING MATERIALS

- A. Remove existing equipment, piping, wiring, construction, etc., which interferes with Work of this Contract. Promptly return to service upon completion of work in the area. Replace items damaged by Contractor with new material to match existing.
- B. Removed materials which will not be re-installed and which are not claimed by Owner shall become the property of Contractor and shall be removed from the Project site. Consult Owner before removing any material from the Project site. Carefully remove materials claimed by Owner to prevent damage and deliver to Owner-designated storage location.
- C. Existing piping and wiring not reused and are concealed in building construction may be abandoned in place and all ends shall be capped or plugged. Remove unused piping and wiring exposed in Equipment Rooms or occupied spaces. Material shall be removed from the premises. Disconnect power, water, gas, pump or any other active energy source from piping or electrical service prior to abandoning in place.

3.2 FRAMING, CUTTING, AND PATCHING

- A. Special framing, recesses, chases and backing for Work of this Section, unless otherwise specified, are covered under other Specification Sections.
- B. Contractor is responsible for placement of pipe sleeves, hangers, inserts, supports, and location of openings for the Work.
- C. Cutting, patching, and repairing of existing construction to permit installation of equipment, and materials is the responsibility of Contractor. Repair or replace damage to existing work with skilled mechanics for each trade.
- D. Cut existing concrete construction with a concrete saw. Do not utilize pneumatic devices.
- E. Core openings through existing construction for passage of new piping and conduits. Cut holes of minimum diameter to suit size of pipe and associated insulation installed. Coordinate with building structure, and obtain Structural Engineer's approval prior to coring through existing construction.

3.3 MECHANICAL DEMOLITION

- A. Refer to Division 01 Sections “Cutting and Patching” and “Selective Demolition” for general demolition requirements and procedures.
- B. Disconnect, dismantle and remove mechanical systems, equipment, and components indicated to be removed. Coordinate with all other trades.
 - 1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 - 2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping to remain with same or compatible piping material. Refrigerant system must be evacuated per EPA requirements.
 - 3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and cap remaining ducts with same or compatible ductwork material.
 - 4. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.
 - 5. Equipment to Be Removed: Drain down and cap remaining services and remove equipment.
 - 6. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 - 7. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
- C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.4 ELECTRICAL REQUIREMENTS

- A. Provide adequate working space around electrical equipment in compliance with the California Electrical Code. Coordinate the Mechanical Work with the Electrical Work to comply.
- B. Furnish necessary control diagrams and instructions for the controls. Before permitting operation of any equipment which is furnished, installed, or modified under this Section, review all associated electrical work, including overload protection devices, and assume complete responsibility for the correctness of the electrical connections and protective devices. Motors and control equipment shall conform to the Standards of the National Electrical Manufacturers' Association. All equipment and connections exposed to the weather shall be NEMA IIIIR with factory-wired strip heaters in each starter enclosure and temperature control panel where required to inhibit condensation.
- C. All line voltage and low voltage wiring and conduit associated with the Temperature Control System are included in this Section. Wiring and conduit shall comply with Division 26.

3.5 PIPING SYSTEM REQUIREMENTS

- A. Drawing plans, schematic and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

3.6 PRIMING AND PAINTING

- A. Perform priming and painting on the equipment and materials as specified herein.
- B. See Division 09 Painting Section(s) for detailed requirements.
- C. Priming and painting:
 - 1. Exposed ferrous metals, including piping, which are not galvanized or factory-finished shall be primed and painted.
 - a. Black Steel Piping:
 - 1) Primer: One coat gray Sherwin-Williams Pro Industrial Pro-Cryl Universal Primer, comparable products by Rust-Oleum, Kelly Moore, or equal.
 - 2) Topcoat: Two coats gray Sherwin-Williams Pro Industrial Waterbased Alkyd Urethane Enamel, comparable products by Rust-Oleum, Kelly Moore, or equal.
 - b. Interior Ductwork: Refer to Division 09 Painting Section(s). Architect shall select paint color.
 - 2. Metal surfaces of items to be jacketed or insulated except ductwork and piping shall be given two coats of primer unless furnished with equivalent factory finish. Items to be primed shall be properly cleaned by effective means free of rust, dirt, scale, grease and other deleterious matter and then primed with the best available grade of zinc rich primer. After erection or installation, all primed surfaces shall be properly cleaned of any foreign or deleterious matter that might impair proper bonding of subsequent paint coatings. Any abrasion or other damage to the shop or field prime coat shall be properly repaired and touched up with the same material used for the original priming.
 - 3. Where equipment is provided with nameplate data, the nameplate shall be masked off prior to painting. When painting is completed, remove masking material.

3.7 EXCAVATING

- A. Perform all excavating required for work of this Section. Provide the services of a pipe/cable locating service prior to excavating activities to determine location of existing utilities.
- B. Unless shown otherwise, provide a minimum of 2'-6" cover above top of pipe to finished grade for all service piping, unless otherwise noted. Trim trench bottom by hand or provide a 4 inch deep minimum bed of sand to provide a uniform grade and firm support throughout entire length of pipe. For all PVC pipe and for PE gas pipe, bed the pipe in 4 inch sand bed. Pipe bedding materials should be clean crushed rock, gravel or sand of which 100 percent will pass a 1 inch sieve. For pipes that are larger than 10 inches in diameter, at least 95 percent should pass a 3/4 inch sieve, and for pipes 10 inches in diameter or smaller, 100 percent should pass a 1/2 inch sieve. All other materials should have a minimum sand equivalent of 50. Only a small proportion of the native soils will meet these requirements without extensive processing; therefore, importation of pipe bedding materials should be anticipated. Pipe bedding materials shall be compacted in lifts not exceeding 6 inches in compacted thickness. Each lift shall be compacted to not less than 90 percent relative compaction at or above the optimum moisture content, in accordance with ASTM Specification D2940, except that bedding materials graded such 100 percent of the material will pass a No. 200 sieve shall be compacted in 6 inch lifts using a single pass of a flat-plate, vibratory compactor or vibratory drum. Pipe bedding materials should extend at least to the spring line.
- C. Maintain all warning signs, barricades, flares, and red lanterns as required.

- D. For all trenches 5 feet or more in depth, submit copy of permit detailed drawings showing shoring, bracing, sloping, or other provisions to be made for worker protection from the hazard of caving ground during the excavation of such trenches. Obtain a permit from the Division of Industrial Safety prior to beginning excavations. A copy of the permit shall be available at the site at all times.

3.8 BACKFILLING

- A. Backfill shall comply with applicable provisions of Division 31 of these Specifications.
- B. Except under existing or proposed paved areas, walks, roads, or similar surfaces, backfill for other types of pipe shall be made using suitable excavated material or other approved material. Place backfill in 8 inch layers, measured before compaction, and compact with impact hammer to at least 90 percent relative compaction per ASTM D2940.
 - 1. Backfill plastic pipe and insulated pipe with sand for a minimum distance of 12 inches above the top of the pipe. Compact using mechanical tamping equipment.
- C. Entire backfill for excavations under existing or proposed pavements, walks, roads, or similar surfaces, under new slabs on grade, shall be made with clean sand compacted with mechanical tamping equipment vibrator to at least 90 percent relative compaction per ASTM D2940. Remove excess earth. Increase the minimum compaction within the uppermost two feet of backfill to 95 percent.
- D. Replace or repair to its original condition all sod, concrete, asphalt paving, or other materials disturbed by the trenching operation. Repair within the guarantee period as required.

3.9 PIPING AND DUCT SYSTEMS INSTALLATION

- A. General:
 - 1. All piping shall be concealed unless shown or otherwise directed. Allow sufficient space for ceiling panel removal.
 - 2. Installation of piping shall be made with appropriate fittings. Bending of piping will not be accepted.
 - 3. Install piping to permit application of insulation and to allow valve servicing.
 - 4. Where piping, conduit, or ductwork is left exposed within a room, the same shall be run true to plumb, horizontal, or intended planes. Where possible, uniform margins are to be maintained between parallel lines and/or adjacent wall, floor, or ceiling surfaces.
 - 5. Horizontal runs of pipes, conduits, or ductwork suspended from ceilings shall provide for a maximum headroom clearance. The clearance shall not be less than 6'-6" without written approval from the Architect.
 - 6. Close ends of pipe immediately after installation. Leave closure in place until removal is necessary for completion of installation.
 - 7. At the time of rough installation, or during storage on the construction site and until final startup of the heating and cooling equipment, all duct and other related air distribution component opening shall be covered with tape, plastic, sheet metal, or other methods acceptable to the enforcing agency.
 - 8. Each piping system shall be thoroughly flushed and proved clean before connection to equipment.
 - 9. Pipe the discharge of each relief valve, air vent, backflow preventer, and similar device to floor sink or drain.
 - 10. Install exposed polished or enameled connections with special care showing no tool marks or threads at fittings.
 - 11. Install horizontal valves with valve stem above horizontal.
 - 12. Use reducing fittings; bushings shall not be allowed. Use eccentric reducing fittings wherever necessary to provide free drainage of lines and passage of air.

13. Verify final equipment locations for roughing-in.
 14. Service Markers: Mark the location of each plugged or capped pipe with a 4 inch round by 30 inch long concrete marker, set flush with finish grade. Provide 2-1/2 inch diameter engraved brass plate as part of monument marker.
 15. Where piping is installed in walls within one inch of the face of stud, provide a 16 gauge sheet metal shield plate on the face of the stud. The shield plate shall extend a minimum of 1-1/2 inches beyond the outside diameter of the pipe.
- B. Expansion Loops:
1. Install expansion loops where piping crosses building expansion or seismic joints, between buildings, between buildings and canopies, and as indicated on Drawings.
 2. Install expansion loops of sizes matching sizes of connected piping.
 3. Install grooved-joint expansion joints to grooved-end steel piping.
 4. Materials of construction and end fitting type shall be consistent with pipe material and type of gas or liquid conveyed by the piping system in which expansion loop is installed.
- C. Sleeves:
1. Install Adjus-to-Crete, Pipeline Seal and Insulator, or equal, pipe sleeves of sufficient size to allow for free motion of pipe, 24 gauge galvanized steel. The space between pipe and sleeves through floor slabs on ground, through outside walls above or below grade, through roof, and other locations as directed shall be caulked with oakum and mastic and made watertight. The space between pipe and sleeve and between sleeve and slab or wall shall be sealed watertight.
 2. At Contractor's option, Link-Seal, Metraflex Metraseal, or equal, casing seals may be used in lieu of caulking. Wrap pipes through slabs on grade with 1 inch thick fiberglass insulation to completely isolate the pipe from the concrete.
- D. Floor, Wall, and Ceiling Plates:
1. Fit all pipes with or without insulation passing through walls, floors, or ceilings, and all hanger rods penetrating finished ceilings with chrome-plated or stainless escutcheon plates.
- E. Firestopping:
1. Pack the annular space between the pipe sleeves and the pipe and between duct openings and ducts through all floors and walls with UL listed fire stop, and sealed at the ends. All pipe penetrations shall be UL listed, Hilti, 3M Pro-Set, or equal.
 - a. Install fire caulking behind mechanical services installed within fire rated walls, to maintain continuous rating of wall construction.
 2. Provide SpecSeal Systems UL fire rated sleeve/coupling penetrators for each pipe penetration or fixture opening passing through floors, walls, partitions or floor/ceiling assemblies. All Penetrators shall comply with UL Fire Resistance Directory (Latest Edition), and in accordance with CBC requirements.
 3. Sleeve penetrators shall have a built in anchor ring for waterproofing and anchoring into concrete pours or use the special fit cored hole penetrator for cored holes.
 4. Copper and steel piping shall have SpecSeal plugs on both sides of the penetrator to reduce noise and to provide waterproofing.
 5. All above Firestopping systems to be installed in strict accordance with manufacturer's instructions.
 6. Alternate firestopping systems are acceptable if approved equal. However, any deviation from the above specification requires the Contractor to be responsible for determining the suitability of the proposed products and their intended use, and the Contractor shall assume all risks and liabilities whatsoever in connection therewith.
- F. Flashing:

1. Flashing for penetrations of metal or membrane roof for mechanical items such as flues, ducts, and pipes shall be coordinated with the roofing manufacturer and roofing installer for the specific roofing type. The work of this section shall include furnishing, layout, sizing, and coordination of penetrations required for the mechanical work.
 - a. Furnish and install flashing and counterflashing in strict conformance with the requirements of the roofing manufacturer. Submit shop drawing details for review prior to installation.
 - b. Furnish and install counterflashing above each flashing required. Provide Stoneman, or equal, vandalproof top and flashing combination. Elmdor/Stoneman Model 1540.
 - c. Flues and ducts shall have 24 gauge galvanized sheet metal storm collar securely clamped to the flue above the flashing.
 2. For all other types of roofing system, furnish and install around each pipe, where it passes through roof, a flashing and counterflashing. All flashing shall be made of four pound seamless sheet lead with 6 inch minimum skirt and steel reinforced boot. Counterflashing shall be cast iron. For vents, provide vandalproof top and flashing combination. Elmdor/Stoneman Model 1100-4.
- G. Hangers and Supports:
1. General: Support ductwork, equipment and piping so that it is firmly held in place by approved iron hangers and supports, and special hangers. Hanger and support components shall support weight of ductwork, equipment and pipe, fluid, and pipe insulation based on spacing between supports with minimum factor of safety of five based on ultimate strength of material used. Do not exceed manufacturer's load rating. Pipe attachments or hangers, of same size as pipe or tubing on which used, or nearest available. Rigidly fasten hose faucets, fixture stops, compressed air outlets, and similar items to the building construction. The Architect shall approve hanger material before installation. Do not support piping or ductwork with plumbers' tape, wire rope, wood, or other makeshift devices. Where building structural members do not match piping and ductwork support spacing, provide "bridging" support members firmly attached to building structural members in a fashion approved by the structural engineer.
 - a. Materials, design, and type numbers for support of piping per Manufacturers' Standardization Society (MSS), Standard Practice (SP)-58.
 - 1) Provide copper-plated or felt-lined hangers for use on copper tubing.
 - b. Materials and design for ductwork support shall be per SMACNA "HVAC Duct Construction Standards, Metal and Flexible."
 2. Hanger components shall be provided by one manufacturer: B-Line, Grinnell, Unistrut, Badger, or equal.
 3. Riser clamps: B-line model B3373, or equal.
 4. Pipe Hanger and Support Placement and Spacing:
 - a. Vertical piping support spacing: Provide riser clamps for piping, above each floor, in contact with the floor. Provide support at joints, branches, and horizontal offsets. Provide additional support for vertical piping, spaced at or within the following maximum limits:

<u>Pipe Diameter</u>	<u>Steel Threaded or Welded (Note 3)</u>	<u>Copper Brazed or Soldered (Notes 3, 4)</u>	<u>CPVC & PVC (Note 2)</u>
1/2 - 1"	12 ft.	Each Floor, Not to Exceed 10 ft.	Base and Each Floor (Note 1)
1-1/4 - 2"	12 ft.	Each Floor, Not to Exceed 10 ft.	Base and Each Floor (Note 1)
2-1/2 - 3"	12 ft.	Each Floor, Not to Exceed 10 ft.	Base and Each Floor (Note 1)
Over 4"	12 ft.	Each Floor, Not to Exceed 10 ft.	Base and Each Floor (Note 1)

- 1) Note 1: Provide mid-story guides.
 - 2) Note 2: For PVC piping, provide for expansion every 30 feet per IAPMO installation standard. For CPVC piping, provide for expansion per IAPMO installation standard.
 - 3) Note 3: Spacing of hangers and supports for piping assembled with mechanical joints shall be in accordance with standards acceptable to authorities having jurisdiction.
 - 4) Note 4: Includes refrigerant piping, including vapor and hot gas pipes.
- b. Horizontal piping, hanger and support spacing: Locate hangers and supports at each change of direction, within one foot of elbow, and spaced at or within following maximum limits:

<u>Pipe Diameter</u>	<u>Steel Threaded or Welded (Note 2)</u>	<u>Copper Brazed or Soldered (Notes 2, 3)</u>	<u>CPVC & PVC (Note 1)</u>
1/2 - 1"	6 ft.	5 ft.	3 ft.
1-1/4 - 2"	7 ft.	6 ft.	4 ft.
2-1/2 - 3"	10 ft.	10 ft.	4 ft.
Over 4"	10 ft.	10 ft.	4 ft.

- 1) Note 1: For PVC piping, provide for expansion every 30 feet per IAPMO installation standard. For CPVC piping, provide for expansion per IAPMO installation standard.
 - 2) Note 2: Spacing of hangers and supports for piping assembled with mechanical joints shall be in accordance with standards acceptable to authorities having jurisdiction.
 - 3) Note 3: Includes all refrigerant piping, including vapor and hot gas pipes.
5. Suspended Piping:
- a. Individually suspended piping: B-Line B3690 J-Hanger or B3100 Clevis, complete with threaded rod, or equal. All hangers on supply and return piping handling heating hot water or steam shall have a swing connector at point of support.

<u>Pipe Size</u>	<u>Rod Size Diameter</u>
2" and Smaller	3/8"
2-1/2" to 3-1/2"	1/2"
4" to 5"	5/8"
6"	3/4"

- b. Provide 3/8 inch rod for support of PVC and CPVC and provide continuous support.
 - c. Trapeze Suspension: B-Line 1-5/8 inch width channel in accordance with manufacturers' published load ratings. No deflection to exceed 1/180 of a span.
 - d. Trapeze Supporting Rods: Shall have a safety factor of five; securely anchor to building structure.
 - e. Pipe Clamps and Straps: B-Line B2000, B2400; isolate copper pipe with two thicknesses of 2 inches wide 10-mil polyvinyl tape. Where used for seismic support systems, provide B-Line B2400 series pipe straps.
 - f. Concrete Inserts: B-line B22-I continuous insert or B2500 spot insert. Do not use actuated fasteners for support of overhead piping unless approved by Architect.
 - g. Above Roof: H frame made from Uni-Strut hot-dipped galvanized 1-5/8 inch single or double channel with P-2072A or P-2073A foot secured to roof and surrounded with waterproof roofed-in sleeper. Secure to sleeper with lag screws, and secure sleeper to blocking under roof.
 - h. Steel Connectors: Beam clamps with retainers.
6. Duct Hanger and Support Spacing: Conform to Requirements of CMC and SMACNA "HVAC Duct Construction Standards, Metal and Flexible."
7. Support to Structure:
- a. Steel Structure: Provide and install additional steel bracing as required to suit structure. Provide through bolts with length to suit requirements of the structural components. Burning or welding on any structural member may only be done if approved by the Architect.
8. Rubber Neoprene Pipe Isolators:
- a. Pipe isolators shall comprise an internal rubber or neoprene material that isolates pipe from hanger and structure. Install at all piping located in acoustical walls. Refer to Architectural Drawings for location of acoustical walls.
 - b. Isolation material shall be either a rubber or neoprene material that prevents contact between the pipe and the structure. The rubber shall have between a 45 to 55 durometer rating and a minimum thickness of 1/2 inch.
 - c. Acceptable Suppliers:
 - 1) Vertical runs: Acousto-Plumb or equal.
 - 2) Horizontal runs: B-Line, Vibraclamp; Acousto-Plumb or equal.
9. Provide support for piping through roof, arranged to anchor piping solidly in place at the roof penetration.
10. Provide rigid insulation and a 12 inch long, 18 gauge galvanized sheet iron shield between the covering and the hanger whenever hangers are installed on the outside of the pipe covering.
11. Insulate copper tubing from ferrous materials and hangers with two thicknesses of 3 inch wide, 10 mil polyvinyl tape wrapped around pipe.
12. Provide a support or hanger close to each change of direction of pipe either horizontal or vertical and as near as possible to concentrated loads.
13. Suspend rods from concrete inserts with removable nuts where suspended from concrete decks. Power actuated inserts will not be allowed.

14. On chilled or combination hot and chilled water or refrigerant pipes, install the hangers on the outside of the pipe covering and not in contact with the pipe. Provide rigid insulation and a 12 inch long, 18 gauge galvanized sheet iron shield between the covering and the hanger whenever hangers are installed on the outside of the pipe covering.

3.10 UNION AND FLANGE INSTALLATION

- A. Install Epco, Nibco, or equal, dielectric unions or flanges at points of connection between copper or brass piping or material and steel or cast iron pipe or material except in drain piping. Bushings or couplings shall not be used.
- B. Install unions in piping NPS 2" and smaller or flanges in piping NPS 2-1/2" and larger whether shown or not at each connection to all equipment and tanks, and at all connections to all automatic valves, such as temperature control valves.
- C. Locate the unions for easy removal of the equipment, tank, or valve.
- D. Do not install unions or flanges in refrigerant piping systems.

3.11 ACCESS DOOR INSTALLATION

- A. Furnish and install access doors wherever required whether shown or not for easy maintenance of mechanical systems; for example, at concealed valves, strainers, traps, cleanouts, dampers, motors, controls, operating equipment, etc. Access doors shall provide for complete removal and replacement of equipment.

3.12 CONCRETE WORK

- A. Concrete work required for work of this Section shall be included under another section of the Specification, unless otherwise noted, including poured-in-place concrete work for installing precast manholes, catch basins, etc., and shall include reinforced concrete bases for pumps, tanks, compressors, fan units, boilers, unless the work is specifically indicated on the Drawings to be furnished under this Section.
- B. Underground anchors, and pads for valve access boxes are included under this Section of the Specification. Concrete shall be 3000 psi test minimum. Refer to Division 03 for concrete types.

3.13 PIPE PROTECTION

- A. Wrap bare galvanized and black steel pipe buried in the ground and to 6" above grade, including piping in conduit, with one of the following, or equal:
 1. Polyethylene Coating: Pressure sensitive polyethylene coating, "X-Tru-Coat" as manufactured by Pipe Line Service Corporation or "Green Line" wrap as manufactured by Royston Products, or equal.
 - a. Field Joints and Fittings: Protecto Wrap #1170 tape as manufactured by Pipe Line Service Corporation, or Primer #200 tape by Royston Products, or equal. Installation shall be as per manufacturer's recommendation and instructions.

2. Tape Wrap: Pressure-sensitive polyvinyl chloride tape, "Transtex #V-10 or V-20", "Scotchwrap 50", Slipknot 100, PASCO Specialty & Mfg., Inc., or equal, with continuous identification. Tape shall be a minimum of 20 mils thick for fittings and irregular surfaces, two wraps, 50 percent overlap, 40 mils total thickness. Tape shall be laminated with a suitable adhesive; widths as recommended by the manufacturer for the pipe size. Wrap straight lengths of piping with an approved wrapping machine.
- B. Field Joints: Valves and Fittings: double wrap polyvinyl chloride tape as above. Provide at least two thicknesses of tape over the joint and extend a minimum of 4 inches over adjacent pipe covering. Build up with primer to match adjacent covering thickness. Width of tape of fittings shall not exceed 3 inches. Tape shall adhere tightly to all surfaces of the fittings without air pockets.
- C. Testing: Test completed wrap of piping, including all epoxy painted piping with Tinker and Razor Co. holiday detector, or equal.
- D. Cleaning: Clean all piping thoroughly before wrapping.
 1. Inspection: Damaged or defective wraps shall be repaired as directed. No wrapped pipe shall be covered until approved by Architect.
- E. Covering: No rocks or sharp edges shall be backfilled against the wrap. When backfilling with other than sand, protect wrap with an outer wrapping of Kraft paper; leave in place during backfill.

3.14 PIPE IDENTIFICATION

- A. Provide temporary identification of each pipe installed, at the time of installation. Temporary identification shall be removed and replaced with permanent identification as part of the work.
- B. Apply the legend and flow arrow at all valve locations; at all points where the piping enters or leaves a wall, partition, cluster of piping or similar obstruction, at each change of direction, and at approximately 20'-0" intervals on pipe runs. Variations or changes in locations and spacing may be made with the approval of the Architect. There shall be at least one marking in each room. Markings shall be located for maximum visibility from expected personnel approach.
- C. Wherever two or more pipes run parallel, the markings shall be supplied in the same relative location on each.
- D. Apply the markings after painting and cleaning of piping and insulation is completed.

3.15 EXPANSION ANCHORS IN HARDENED CONCRETE

- A. Refer to Structural Drawings.

3.16 PIPING SYSTEM PRESSURE TESTING

- A. General:
 1. Perform operational tests under simulated or actual service conditions.
 2. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.

- B. Piping Systems: Test the installations in accordance with the following requirements and applicable codes:
 1. Notify the Architect at least seven days in advance of testing.
 2. Authority having jurisdiction shall witness tests of piping systems.
 3. Piping shall be tested at completion of roughing-in, or at other times as directed by the Architect.
 4. Furnish necessary materials, test pumps, gases, instruments and labor required for testing.
 5. Isolate from system equipment that may be damaged by test pressure.
 6. Test Schedule: No loss in pressure or visible leaks shall show after four hours at the pressures indicated.

<u>System Tested</u>	<u>Test Pressure PSI</u>	<u>Test With</u>
All Hot, Chilled, Combination, Condenser Water Piping	Greater of 1-1/2 x WP or 100 psi	Water

- C. Testing, Evacuating, Charging and Lubrication of Refrigeration Systems:
 1. Pressurize with dry nitrogen and/or refrigerant to 300 psig and test all joints with an electronic detector or halide torch. Release the pressure and attach a high vacuum pump. Evacuate to 4 mm (4000 microns) and hold for 30 minutes. Break to 5 psig with dry nitrogen and allow to remain in the system for ten minutes. Evacuate to 2 mm (2000 microns) and hold for 30 minutes. Use a mercury manometer or electronic vacuum gauge. Do not start timing until recommended vacuum range is reached.
 2. At the end of the evacuation, if the system has been proved leak-free, charge with refrigerant and fill the crankcase to the oil level specified by the manufacturer. All refrigerant oil shall be delivered to the location in sealed containers.
 3. Replenish for a period of one year without cost to the Owner all refrigerant and oil required to maintain the proper levels.

3.17 OPERATION OF SYSTEMS

- A. Do not operate any mechanical equipment for any purpose, temporary or permanent, until all of the following has been completed:
 1. Complete all requirements listed under “Check, Test and Start Requirements.”
 2. Ductwork and piping has been properly cleaned. Piping systems shall be flushed and treated prior to operation.
 3. Filters, strainers etc. are in place.
 4. Bearings have been lubricated, and alignment of rotating equipment has been checked.
 5. Equipment has been run under observation, and is operating in a satisfactory manner.
- B. Provide test and balance agency with one set of Contract Drawings, Specifications, Addenda, Change orders issued, applicable shop drawings and submittals and temperature control drawings.
- C. Operate every fire damper, smoke damper, combination smoke and fire damper under normal operating conditions. Activate smoke detectors as required to operate the damper, stage fan, etc. Provide written confirmation that all systems operate in a satisfactory manner.

3.18 CHECK, TEST AND START REQUIREMENTS

- A. An authorized representative of the equipment manufacturer shall perform check, test and start of each piece of mechanical equipment. The representative may be an employee of the equipment manufacturer, or a manufacturer-certified contractor. Submit written certification from the manufacturer stating that the representative is qualified to perform the check test and start of the equipment.
 - 1. As part of the submittal process, provide a copy of each manufacturer's printed startup form to be used.
 - 2. Some items of specified equipment may require that check, test and start of equipment must be performed by the manufacturer, using manufacturer's employees. See specific equipment Articles in these Specifications for this requirement.
 - 3. Provide all personnel, test instruments, and equipment to properly perform the check, test and start work.
 - 4. When work has been completed, provide copies of reports for review, prior to final observation of work.
- B. Provide copies of the completed check, test and start report of each item of equipment, bound with the Operation and Maintenance Manual.
- C. Upon completion of the work, provide a schedule of planned maintenance for each piece of equipment. Indicate frequency of service, recommended spare parts (including filters and lubricants), and methods for adjustment and alignment of all equipment components. Provide a copy of the schedule with each Operation and Maintenance Manual. Provide a copy of certification from the Owner's representative indicating that they have been properly instructed in maintenance requirements for the equipment installed.

3.19 PRELIMINARY OPERATIONAL REQUIREMENTS AND TESTS

- A. Prior to observation to determine final acceptance, put HVAC, plumbing, and fire protection systems into service and check that work required for that purpose has been done, including but not limited to the following condensed check list. Provide indexed report to tabulating the results of all work.
 - 1. All equipment has been started, checked, lubricated and adjusted in accordance with the manufacturer's recommendations, including modulating power exhausts if present.
 - 2. Correct rotation of motors and ratings of overload heaters are verified.
 - 3. Specified filters are installed and spare filters have been turned over to Owner.
 - 4. All manufacturers' certificates of start-up specified have been delivered to the Owner.
 - 5. All equipment has been cleaned, and damaged painted finishes touched up.
 - 6. Damaged fins on heat exchangers have been combed out.
 - 7. Missing or damaged parts have been replaced.
 - 8. Flushing and chemical treatment of piping systems has been completed and water treatment equipment, where specified, is in operation.
 - 9. Equipment labels, pipe marker labels, ceiling markers and valve tags are installed.
 - 10. Valve tag schedules, corrected control diagrams, sequence of operation lists and start-stop instructions have been posted.
 - 11. Preliminary test and balance work is complete, and reports have been forwarded for review.
 - 12. Automatic control set points are as designated and performance of controls checks out to agree with the sequence of operation.
 - 13. Operation and Maintenance Manuals have been delivered and instructions to the operating personnel have been made.

- B. Prior to the observation to determine final acceptance, operate all mechanical systems as required to demonstrate that the installation and performance of these systems conform to the requirements of these specifications.
 - 1. Operate and test all mechanical equipment and systems for a period of at least five consecutive 8 hour days to demonstrate the satisfactory overall operation of the project as a complete unit.
 - 2. Include operation of heating and air conditioning equipment and systems for a period of not less than two 8 hour days at not less than 90 percent of full specified heating and cooling capacities in tests.
 - 3. Commence tests after preliminary balancing and adjustments to equipment have been checked. Immediately before starting tests, install air filters and lubricate all running equipment. Notify the Architect at least seven calendar days in advance of starting the above tests.
 - 4. During the test period, make final adjustments and balancing of equipment, systems controls, and circuits so that all are placed in first class operating condition.
 - 5. Where Utility District rebates are applicable, demonstrate that the systems meet the rebate program requirements.

- C. Before handing over the system to Owner replace all filters with complete new set of filters.

- D. Review of Contractor's Tests:
 - 1. All tests made by the Contractor or manufacturers' representatives are subject to observation and review by the Owner. Provide timely notice prior to start of each test, in order to allow for observation of testing. Upon the completion of all tests, provide a letter to confirm that all testing has been successful.

- E. Test Logs:
 - 1. Maintain test logs listing the tests on all mechanical systems showing dates, items tested, inspectors' names, remarks on success or failure of the tests.

- F. Preliminary Operation:
 - 1. The Owner reserves the right to operate portions of the mechanical system on a preliminary basis without voiding the guarantee.

- G. Operational Tests:
 - 1. Before operational tests are performed, demonstrate that all systems and components are complete and fully charged with operating fluid and lubricants.
 - 2. Systems shall be operable and capable of maintaining continuous uninterrupted operation during the operating and demonstration period. After all systems have been completely installed, connections made, and tests completed, operate the systems continuously for a period of five working days during the hours of a normal working day.
 - 3. This period of continuous systems operation may be coordinated with the removal of Volatile Organic Compounds (VOCs) from the building prior to occupancy should the Owner decide to implement such a program.
 - 4. Control systems shall be completely operable with settings properly calibrated and adjusted.
 - 5. Rotating equipment shall be in dynamic balance and alignment.
 - 6. If the system fails to operate continuously during the test period, the deficiencies shall be corrected and the entire test repeated.

- H. Pre-Occupancy Building Purge:
 - 1. Prior to occupancy, ventilate the building on 100 percent outside air, 100 percent exhaust for a continuous period determined by a qualified industrial hygienist (engaged by the Contractor) to reduce V.O.C's prior to occupancy.

2. Submit report by the industrial hygienist verifying satisfactory completion of the pre-occupancy purge.

3.20 DEMONSTRATION AND TRAINING

- A. An authorized representative of the equipment manufacturer shall train Owner-designated personnel in maintenance and adjustment of equipment. The representative may be an employee of the equipment manufacturer, or a manufacturer-certified contractor. Submit written certification from the manufacturer stating that the representative is qualified to perform the Owner training for the equipment installed.
 1. As part of the submittal process, provide a training agenda outlining major topics and time allowed for each topic.
 2. Some items of specified equipment require that training must be performed by the manufacturer, using manufacturer's employees. See specific equipment Articles in these Specifications for this requirement.
 3. Contractor shall provide three copies of certification by Contractor that training has been completed, signed by Owner's representative, for inclusion in Operation and Maintenance Manual. Certificates shall include:
 - a. Listing of Owner-designated personnel completing training, by name and title.
 - b. Name and title of training instructor.
 - c. Date(s) of training.
 - d. List of topics covered in training sessions.
 4. Refer to specific equipment Articles for minimum training period duration for each piece of equipment.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Balancing Air Systems:
 - a. Constant-volume air systems.
 - b. Variable-air-volume systems.
 - c. Multizone systems.
 - 2. Balancing Hydronic Piping Systems:
 - a. Variable-flow hydronic systems.
 - b. Primary-secondary hydronic systems.
 - 3. Balancing Domestic Water Piping Systems.

1.2 RELATED REQUIREMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 REFERENCES AND STANDARDS

- A. Associated Air Balance Council (AABC)
 - 1. National Standards for Total System Balance, latest edition.
- B. National Environmental Balancing Bureau (NEBB)
 - 1. Procedural Standards for Testing and Balancing of Environmental Systems, latest edition.

1.4 DEFINITIONS

- A. The intent of this Section is to use the standards pertaining to the TAB specialist engaged to perform the Work of this Contract, with additional requirements specified in this Section. Contract requirements take precedence over corresponding AABC or NEBB standards requirements. Differences in terminology between the Specifications and the specified TAB organization standards do not relieve the TAB entity engaged to perform the Work of this Contract of responsibility from completing the Work as described in the Specifications.
- B. Similar Terms: The following table is provided for clarification only:

<u>Similar Terms</u>		
Contract Term	AABC Term	NEBB Term
TAB Specialist	TAB Agency	NEBB Certified Firm
TAB Standard	National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems	Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems
TAB Field Supervisor	Test and Balance Engineer	Test and Balance Supervisor

- C. AABC: Associated Air Balance Council.
- D. NEBB: National Environmental Balancing Bureau.
- E. TAB: Testing, adjusting, and balancing.
- F. TAB Organization: Body governing practices of TAB Specialists.
- G. TAB Specialist: An entity engaged to perform TAB Work.

1.5 ACTION SUBMITTALS

- A. For additional requirements, refer to Section 23 00 50, Basic HVAC Materials and Methods.

1.6 INFORMATIONAL SUBMITTALS

- A. For additional requirements, refer to Section 23 00 50, Basic HVAC Materials and Methods.
- B. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
 - 1. Provide list of similar projects completed by proposed TAB field supervisor.
 - 2. Provide copy of completed TAB report, approved by mechanical engineer of record for a completed project with similar system types and of similar complexity.
- C. Contract Documents Examination Report: Within 30 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.
 - 1. Submit examinations report with qualifications data.
- D. Strategies and Procedures Plan: Within 60 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.
- E. Interim Reports. Submit interim reports as specified in Part 3. Include list of system conditions requiring correction and problems not identified in Contract Documents examination report.
- F. Certified TAB reports.

1. Provide three printed copies of final TAB report. Provide one electronic file copy in PDF format.
- G. Sample report forms.
- H. Instrument calibration reports, to include the following:
 1. Instrument type and make.
 2. Serial number.
 3. Application.
 4. Dates of use.
 5. Dates of calibration.
 - a. Instruments to be used for testing and balancing shall have been calibrated within a period of one year, or less if so recommended by instrument manufacturer and be checked for accuracy prior to start of work.

1.7 CLOSEOUT SUBMITTALS

- A. For additional requirements, refer to Section 23 00 50, Basic HVAC Materials and Methods.
- B. Certified TAB reports, for inclusion in Operation and Maintenance Manual.

1.8 QUALITY ASSURANCE

- A. Independent TAB Specialist Qualifications: Engage a TAB entity certified by AABC or NEBB.
 1. The certification shall be maintained for the entire duration of TAB work for this Project. If TAB specialist loses certification during this period, the Contractor shall immediately notify the Architect and submit another TAB specialist for approval. All work specified in this Section and in other related Sections performed by the TAB specialist shall be invalidated if the TAB specialist loses certification, and shall be performed by an approved successor.
- B. To secure approval for the proposed TAB specialist, submit information certifying that the TAB specialist is either a first tier subcontractor engaged and paid by the Contractor, or is engaged and paid directly by the Owner. TAB specialist shall not be affiliated with any other entity participating in Work of this Contract, including design, furnishing equipment, or construction. In addition, submit evidence of the following:
 1. TAB Field Supervisor: Full-time employee of the TAB specialist and certified by AABC or NEBB.
 - a. TAB field supervisor shall have minimum 10 years supervisory experience in TAB work.
 2. TAB Technician: Full-time employee of the TAB specialist and who is certified by AABC or NEBB as a TAB technician.
 - a. TAB technician shall have minimum 4 years TAB field experience.
- C. TAB Specialist engaged to perform TAB work in this Project shall be a business limited to and specializing in TAB work, or in TAB work and Commissioning.
- D. TAB specialist engaged to perform TAB work shall not also perform commissioning activities on this Project.
- E. Certified TAB field supervisor or certified TAB technician shall be present at the Project site at all times when TAB work is performed.

1. TAB specialist shall maintain at the Project site a minimum ratio of one certified field supervisor or technician for each non-certified employee at times when TAB work is being performed.

- F. Contractor shall notify Architect in writing within three days of receiving direction resulting in reduction of test and balance scope or other deviations from Contract Documents. Deviations from the TAB plan shall be approved in writing by the mechanical engineer of record for the Project.

- G. TAB Standard:
 1. Perform TAB work in accordance with the requirements of the standard under which the TAB agencies' qualifications are approved unless Specifications contain different or more stringent requirements:
 - a. AABC National Standards for Total System Balance, or
 - b. NEBB Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems.
 2. All recommendations and suggested practices contained in the TAB standard are mandatory. Use provisions of the TAB standard, including checklists and report forms, to the extent to which they are applicable to this Project.
 3. Testing, adjusting, balancing procedures, and reporting required for this Project, and not covered by the TAB standard applicable to the TAB specialist engaged to perform the Work of this Contract, shall be submitted for approval by the design engineer.

- H. Certify TAB field data reports and perform the following:
 1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
 2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.

- I. TAB Report Forms: Use standard TAB specialist's forms approved by Architect .

- J. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

1.9 PROJECT CONDITIONS

1.10 WARRANTY

- A. Provide workmanship and performance warranty applicable to TAB specialist engaged to perform Work of this Contract:
 1. AABC Performance Guarantee.
 2. NEBB Quality Assurance Program.

- B. Refer to Division 01 Specifications for additional requirements.

1.11 COORDINATION

- A. Notice: Provide days' advance notice for each test. Include scheduled test dates and times.

- B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

- C. Coordinate TAB work with work of other trades.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Contract Documents Examination Report:
 - 1. TAB specialist shall review Contract Documents, including plans and specifications. Provide report listing conditions that would prevent the system(s) from operating in accordance with the sequence of operations specified, or would prevent accurate testing and balancing:
 - a. Identify each condition requiring correction using equipment designation shown on Drawings. Provide room number, nearest building grid line intersection, or other information necessary to identify location of condition requiring correction.
 - b. Proposed corrective action necessary for proper system operation.
- B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine equipment performance data including fan and pump curves.
 - 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
- F. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- G. Examine test reports specified in individual system and equipment Sections.
- H. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- I. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.
- J. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.
- K. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.
- L. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- M. Examine system pumps to ensure absence of entrained air in the suction piping.
- N. Examine operating safety interlocks and controls on HVAC equipment.

- O. Report conditions requiring correction discovered before and during performance of TAB procedures.
- P. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

- A. Prepare a TAB plan that includes strategies and step-by-step procedures. TAB plan shall be specific to Project and include the following:
 - 1. General description of each air system and sequence(s) of operation.
 - 2. Complete list of measurements to be performed.
 - 3. Complete list of measurement procedures. Specify types of instruments to be utilized and method of instrument application.
 - 4. Qualifications of personnel assigned to Project.
 - 5. Single-line CAD drawings reflecting all test locations (terminal units, grilles, diffusers, traverse locations, etc).
 - 6. Air terminal correction factors for the following:
 - a. Air terminal configuration.
 - b. Flow direction (supply or return/exhaust).
 - c. Effective area of each size and type of air terminal.
 - d. Air density.
- B. Complete system-readiness checks and prepare reports. Verify the following:
 - 1. Permanent electrical-power wiring is complete.
 - 2. Hydronic systems are filled, clean, and free of air.
 - 3. Automatic temperature-control systems are operational.
 - 4. Equipment and duct access doors are securely closed.
 - 5. Balance, smoke, and fire dampers are open.
 - 6. Isolating and balancing valves are open and control valves are operational.
 - 7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
 - 8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
 - 1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
 - 2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 23 80 00 Heating, Ventilating, and Air Conditioning."
- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Test each system to verify building or space operating pressure, including all stages of economizer cycle. Maximum building pressure shall not exceed 0.03 inches of pressure.
- C. Except as specifically indicated in this Specification, Pitot tube traverses shall be made of each duct to measure airflow. Pitot tubes, associated instruments, traverses, and techniques shall conform to ASHRAE Handbook, HVAC Applications, and ASHRAE Handbook, HVAC Systems and Equipment.
 - 1. Use state-of-the-art instrumentation approved by TAB specialists governing agency..
 - 2. Where ducts' design velocity and air quantity are both less than 1000 fpm/CFM, air quantity may be determined by measurements at terminals served.
- D. Test holes shall be placed in straight duct, as far as possible downstream from elbow, bends, take-offs, and other turbulence-generating devices.
- E. For variable-air-volume systems, develop a plan to simulate diversity.
- F. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- G. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- H. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- I. Verify that motor starters are equipped with properly sized thermal protection.
- J. Check dampers for proper position to achieve desired airflow path.
- K. Check for airflow blockages.
- L. Check condensate drains for proper connections and functioning.
- M. Check for proper sealing of air-handling-unit components.
- N. Verify that air duct system is sealed as specified in Section 23 80 00 "Heating, Ventilating, and Air Conditioning."
- O. Provide for adjustments or modifications to fan and motor sheaves, belts, damper linkages, and other components as required to achieve specified air balance at no additional cost to Owner.
- P. Automatically operated dampers shall be adjusted to operate as indicated in Contract Documents. Controls shall be checked for proper calibration.

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.
 - a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow. Alternative methods shall be examined for determining total CFM, i.e., Pitot-tube traversing of branch ducts, coil or filter velocity profiles, prior to utilizing airflow values at terminal outlets and inlets.
 2. Measure fan static pressures as follows to determine actual static pressure:
 - a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
 - b. Measure static pressure directly at the fan outlet.
 - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
 - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
 3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
 - a. Report the cleanliness status of filters and the time static pressures are measured.
 4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
 5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
 6. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
 7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Check operation of relief air dampers. Measure total relief air quantity at each stage of normal, economizer, power exhaust, or power exhaust economizer operation, as applicable to installed equipment. Adjust relief air dampers to provide 100 percent relief in economizer mode. Ensure that relief dampers close completely upon unit shutdown.
- C. Check operation of outside air dampers. Measure total outside air quantity at each stage of normal, economizer, power exhaust, or power exhaust economizer operation, as applicable to installed equipment. Adjust outside air dampers to provide 100 percent outside air in economizer mode. Ensure that outside air dampers close completely upon unit shutdown.
- D. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
 1. Measure airflow of submain and branch ducts.
 - a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
 2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
 3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.
- E. Measure air outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading digital backflow compensating hood. Use outlet manufacturer's written instructions and calculating factors only when direct-reading hood cannot be used due to physical obstruction or other limiting factors. Final report shall indicate where values listed have not been obtained by direct measurement.
- F. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.
 1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents, if included.
 2. Adjust patterns of adjustable outlets for proper distribution without drafts. Terminal air velocity at five feet above finished floor shall not exceed 50 feet per minute in occupied air conditioned spaces.
- G. Do not overpressurize ducts.

3.6 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

- A. Comply with applicable requirements for constant-volume air systems in addition to those listed below.
- B. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a minimum set-point airflow with the remainder at maximum-airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.
- C. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
 1. Set outdoor-air dampers at minimum, and set return- and exhaust-air dampers at a position that simulates full-cooling load.
 2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
 3. Measure total system airflow. Adjust to within indicated airflow.
 4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
 5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.
 - a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.
 6. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
 - a. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.
 7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.
 8. Record final fan-performance data including optimum operating static control set point.

3.7 PROCEDURES FOR MULTIZONE SYSTEMS

- A. Comply with applicable requirements for constant-volume air systems in addition to those listed below.
- B. Set unit at maximum airflow through the cooling coil.
- C. Adjust each zone's balancing damper to achieve indicated airflow within the zone.

3.8 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

- A. Complete air balance prior to hydronic systems balancing.
- B. Prepare test reports with pertinent design data, and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against the approved pump flow rate. Correct variations that exceed ranges given in article, Tolerances.
- C. Prepare schematic diagrams of systems' "as-built" piping layouts.
- D. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:
 - 1. Open all manual valves for maximum flow.
 - 2. Check liquid level in expansion tank.
 - 3. Check makeup water-station pressure gage for adequate pressure for highest vent.
 - 4. Check flow-control valves for specified sequence of operation, and set at indicated flow.
 - 5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
 - 6. Set system controls so automatic valves are wide open to heat exchangers.
 - 7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
 - 8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.9 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

- A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

3.10 PROCEDURES FOR PRIMARY-SECONDARY HYDRONIC SYSTEMS

- A. Balance the primary circuit flow first and then balance the secondary circuits.

3.11 PROCEDURES FOR MOTORS

- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 - 1. Manufacturer's name, model number, and serial number.
 - 2. Motor horsepower rating.
 - 3. Motor rpm.
 - 4. Efficiency rating.
 - 5. Nameplate and measured voltage, each phase.
 - 6. Nameplate and measured amperage, each phase.
 - 7. Starter manufacturer's name, model number, size, type, and thermal-protection-element rating.

- a. Starter strip heater size, type, and rating.
- B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.12 PROCEDURES FOR CONDENSING UNITS

- A. Verify proper rotation of fans.
- B. Measure entering- and leaving-air temperatures.
- C. Record compressor data.

3.13 PROCEDURES FOR BOILERS

- A. Hydronic Boilers: Measure and record entering- and leaving-water temperatures and water flow.
- B. Steam Boilers: Measure and record entering-water temperature and flow and leaving-steam pressure, temperature, and flow.

3.14 GENERAL PROCEDURES FOR PLUMBING SYSTEMS

- A. Measure pressure drop across each backflow preventer assembly at design flows.
- B. Measure water flow at pumps. Use the following procedures except for positive-displacement pumps:
 - 1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
 - a. If impeller sizes must be adjusted to achieve pump performance, obtain approval from Architect Owner Construction Manager Commissioning Authority and comply with requirements in Section 22 50 00 "Plumbing Equipment
 - 2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.
 - a. Monitor motor performance during procedures and do not operate motors in overload conditions.
 - 3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
 - 4. Report flow rates that are not within range given in article, Tolerances.
- C. Set calibrated balancing valves, if installed, at calculated presettings.
- D. Measure flow at all stations and adjust, where necessary, to obtain first balance.
 - 1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.

- E. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.
- F. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:
 - 1. Determine the balancing station with the highest percentage over indicated flow.
 - 2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
 - 3. Record settings and mark balancing devices.
- G. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.
- H. Measure the differential-pressure-control-valve settings existing at the conclusion of balancing.
- I. Check settings and operation of each safety valve. Record settings.

3.15 TOLERANCES

- A. Set HVAC system's air flow rates and water flow rates within the following tolerances:
 - 1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus 10 percent and minus 0 percent.
 - 2. Air Outlets and Inlets: Plus 5 percent and minus 5 percent.
 - 3. Multiple outlets within single room: Plus 5 percent and minus 0 percent for total airflow within room. Tolerance for individual outlets within a single room having multiple outlets shall be as for "Air Outlets and Inlets."
 - a. Room shall be balanced to create pressure relationship (positive, negative, or neutral) with adjacent spaces as indicated on Drawings. Maintain airflow differentials between supply, return, and exhaust indicated on Drawings.
 - 4. Heating-Water Flow Rate: Plus or minus 10 percent.
 - 5. Cooling-Water Flow Rate: Plus or minus 10 percent.
- B. Set plumbing systems water flow rates within plus or minus 10 percent.

3.16 REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.
- B. Interim Reports: Prepare periodic lists of conditions requiring correction and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.17 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing field supervisor. Report shall be co-signed by the Contractor, attesting that he has reviewed the report, and the report has been found to be complete and accurate.
 2. The certification sheet shall be followed by sheet(s) listing items for which balancing objectives could not be achieved. Provide explanation for failure to achieve balancing objectives for each item listed.
 3. Include a list of instruments used for procedures, along with proof of calibration.
- B. Final Report Contents: In addition to certified field-report data, include the following:
1. Pump curves.
 2. Fan curves.
 3. Manufacturers' test data.
 4. Field test reports prepared by system and equipment installers.
 5. Other information relative to equipment performance; do not include Shop Drawings and product data.
- C. General Report Data: In addition to form titles and entries, include the following data:
1. Title page.
 2. Name and address of the TAB specialist.
 3. Project name.
 4. Project location.
 5. Project Performance Guaranty
 6. Architect's name and address.
 7. Engineer's name and address.
 8. Contractor's name and address.
 9. Report date.
 10. Signature of TAB supervisor who certifies the report.
 11. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 12. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 13. Nomenclature sheets for each item of equipment.
 14. Data for terminal units, including manufacturer's name, type, size, and fittings.
 15. Test conditions for fans and pump performance forms including the following:
 - a. Settings for outdoor-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Face and bypass damper settings at coils.
 - e. Fan drive settings including settings and percentage of maximum pitch diameter.
 - f. Inlet vane settings for variable-air-volume systems.
 - g. Settings for supply-air, static-pressure controller.
 - h. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outdoor, supply, return, and exhaust airflows.
 2. Water and steam flow rates.
 3. Duct, outlet, and inlet sizes.
 4. Pipe and valve sizes and locations.
 5. Terminal units.
 6. Balancing stations.

7. Position of balancing devices.
- E. Air distribution outlets and inlets shall be shown on keyed plans with designation for each outlet and inlet matching designation used in Contract Documents and TAB test reports. Room numbers shall be included in keyed plans and test reports. Where multiple outlets and inlets are installed within a single room, a designation shall be assigned and listed for each outlet and inlet in addition to room number.
- F. Test Reports – General:
 1. All test reports containing air or liquid flow data shall record flow values prior to system adjustment in addition to required data listed for each test report.
- G. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:
 1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Unit arrangement and class.
 - g. Discharge arrangement.
 - h. Sheave make, size in inches, and bore.
 - i. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - j. Number, make, and size of belts.
 - k. Number, type, and size of filters.
 2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 3. Test Data (Indicated and Actual Values):
 - a. Total air flow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Filter static-pressure differential in inches wg.
 - f. Cooling-coil static-pressure differential in inches wg.
 - g. Heating-coil static-pressure differential in inches wg.
 - h. Outdoor airflow in cfm.
 - i. Return airflow in cfm.
 - j. Relief airflow in cfm.
 - k. Outdoor-air damper position, normal and economizer, power exhaust, or power exhaust economizer modes, as applicable to installed equipment.
 - l. Return-air damper position.
 - m. Relief-air damper position, normal and economizer, power exhaust, or power exhaust economizer modes, as applicable to installed equipment.
- H. Fan Test Reports: For supply, return, and exhaust fans, include the following:
 1. Fan Data:
 - a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and size.

- e. Manufacturer's serial number.
- f. Arrangement and class.
- g. Sheave make, size in inches, and bore.
- h. Center-to-center dimensions of sheave, and amount of adjustments in inches.
- 2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - g. Number, make, and size of belts.
- 3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Suction static pressure in inches wg.
- I. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
 - 1. Report Data:
 - a. System and air-handling-unit number.
 - b. Location and zone.
 - c. Traverse air temperature in deg F.
 - d. Duct static pressure in inches wg.
 - e. Duct size in inches.
 - f. Duct area in sq. ft..
 - g. Indicated air flow rate in cfm.
 - h. Indicated velocity in fpm.
 - i. Actual air flow rate in cfm.
 - j. Actual average velocity in fpm.
 - k. Barometric pressure in psig.
- J. Air-Terminal-Device Reports:
 - 1. Unit Data:
 - a. System and air-handling unit identification.
 - b. Location and zone.
 - c. Apparatus used for test.
 - d. Area served.
 - e. Make.
 - f. Number from system diagram.
 - g. Type and model number.
 - h. Size.
 - i. Effective area in sq. ft.
 - 2. Test Data (Indicated and Actual Values):
 - a. Air flow rate in cfm.
 - b. Air velocity in fpm.
 - c. Preliminary air flow rate as needed in cfm.
 - d. Preliminary velocity as needed in fpm.
 - e. Final air flow rate in cfm.
 - f. Final velocity in fpm.
 - g. Space temperature in deg F.
- K. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data:
 - a. System and air-handling-unit identification.
 - b. Location and zone.
 - c. Room or riser served.
 - d. Coil make and size.
 - e. Flowmeter type.
 2. Test Data (Indicated and Actual Values):
 - a. Air flow rate in cfm.
 - b. Entering-water temperature in deg F.
 - c. Leaving-water temperature in deg F.
 - d. Water pressure drop in feet of head or psig.
 - e. Entering-air temperature in deg F.
 - f. Leaving-air temperature in deg F.
- L. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:
1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Service.
 - d. Make and size.
 - e. Model number and serial number.
 - f. Water flow rate in gpm.
 - g. Water pressure differential in feet of head or psig.
 - h. Required net positive suction head in feet of head or psig.
 - i. Pump rpm.
 - j. Impeller diameter in inches.
 - k. Motor make and frame size.
 - l. Motor horsepower and rpm.
 - m. Voltage at each connection.
 - n. Amperage for each phase.
 - o. Full-load amperage and service factor.
 - p. Seal type.
 2. Test Data (Indicated and Actual Values):
 - a. Static head in feet of head or psig.
 - b. Pump shutoff pressure in feet of head or psig.
 - c. Actual impeller size in inches.
 - d. Full-open flow rate in gpm.
 - e. Full-open pressure in feet of head or psig.
 - f. Final discharge pressure in feet of head or psig.
 - g. Final suction pressure in feet of head or psig.
 - h. Final total pressure in feet of head or psig.
 - i. Final water flow rate in gpm.
 - j. Voltage at each connection.
 - k. Amperage for each phase.
- M. Instrument Calibration Reports:
1. Report Data:
 - a. Instrument type and make.
 - b. Serial number.
 - c. Application.
 - d. Dates of use.
 - e. Dates of calibration.

3.18 INSPECTIONS

- A. Initial Inspection:
 - 1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
 - 2. Check the following for each system:
 - a. Measure airflow of at least 10 percent of air outlets.
 - b. Measure water flow of at least 5 percent of terminals.
 - c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
 - d. Verify that balancing devices are marked with final balance position.
 - e. Note deviations from the Contract Documents in the final report.

- B. Final Inspection:
 - 1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Architect.
 - 2. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of Architect.
 - 3. Architect shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
 - 4. If rechecks yield measurements that differ from the measurements documented in the final report by more than 10 percent, the measurements shall be noted as "FAILED."
 - 5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

- C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:
 - 1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
 - 2. If the second final inspection also fails, Owner may contact the TAB specialists' governing organization for remedial action by the governing organization under the workmanship and performance warranty. See article, Warranty.
 - 3. If remedial action is not provided by the TAB specialists' governing organization in a timely manner, Owner may contract the services of another TAB specialist to complete the TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB specialists' final payment.

- D. Prepare test and inspection reports.

3.19 ADDITIONAL TESTS

- A. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Furnish all labor, materials, equipment, and service necessary for a complete and operating Native BACnet based Temperature Control System based upon the ANSI/ASHRAE™ Standard 135–2008, BACnet.
- B. Provide all necessary hardware and software to meet the specified functional requirements.
- C. Prepare individual hardware layouts, interconnection drawings and control loop configuration data from project design data.
- D. Implement the detailed design for all system input/output points, distributed control and system data bases, graphic displays, logs, and management reports based on control descriptions, logic drawings, configuration data, and bid documents.
- E. Provide and install all controllers, panels, and all interconnecting data communication network cables and all interconnecting cables between all operator terminals and peripheral devices (such as printers, etc.) called for in this section.
- F. Provide as-built documentation, software, and all Direct Digital Control (DDC) control logic and all associated support documentation on approved media which accurately represents the final system.
- G. Supply all equipment and accessories in accordance with the requirements of all applicable national, state and local codes.
- H. Scheduled equipment performance is minimum capacity required.
- I. Scheduled electrical capacity shall be considered as maximum available.
- J. Unless noted otherwise, all conduit and wiring associated with the temperature control system, regardless of voltage, is included as part of this Section. Obtain power for temperature control devices from the nearest available adequate source.
- K. Control system shall incorporate a California Energy Commission listed and approved fault detection and diagnostic (FDD) economizer controls and Title 24 requirements for HVAC operation with space occupancy sensors.

1.2 RELATED DOCUMENTS

- A. MECHANICAL WORK - GENERAL REQUIREMENTS: Section 23 00 50
- B. HEATING, VENTILATING AND AIR CONDITIONING: Section 23 80 00
- C. GENERAL REQUIREMENTS, ELECTRICAL: Section 26 01 00

1.3 REFERENCES

- A. CCR - California Code of Regulations, Title 24, Part 3, Basic Electrical Requirements, State Building Standards Electrical Code.
- B. CEC - California Electrical Code
- C. NEMA - National Electrical Manufacturer's Association

- D. NFPA - 70 National Electrical Code (NEC)
- E. UL - Underwriters Laboratories, Inc

1.4 SUBMITTALS

- A. Submit eight copies of shop drawings of the entire control system. Provide point to point wiring diagrams and engineered drawings, complete list of equipment and materials including manufacturer's catalog cuts, and installation instructions. Provide a recommended spare parts list.
- B. Provide complete wiring and schematic diagrams, software descriptions, calculations, and any other details required to demonstrate that the system has been coordinated and will properly function as a system. Indicate terminal identification for all control wiring on the shop drawings.
- C. Provide a complete written Sequence of Operations with the submittal package.
- D. Provide the following minimum system documentation:
- E. System configuration diagrams in simplified block format.
- F. Input / Output point and alarm point summary listing.
- G. Electrical drawings showing all system internal and external connection points, terminal block layouts and terminal identification.
- H. As part of Maintenance and Operating Data, provide manufacturer's instructions and drawings for installation, maintenance and operation of all materials.
- I. Overall system operation and maintenance instructions, including preventive maintenance and troubleshooting instructions.
- J. Upon completion of the work provide a complete set of 'record' drawings including manufacturer's descriptive literature, operating instructions, and maintenance and repair data all in accordance with the requirements of Section 23 05 00.
- K. Provide one CD ROM to the Owner with all Control System As-Built AutoCAD Drawings.

1.5 MANUFACTURER QUALITY ASSURANCE

- A. All BACnet application specific controllers submitted for use on this project must be certified as compliant with BACnet through the BACnet Manufacturers' Association (BMA) BACnet Testing Lab and must have a "BTL Mark". The temperature control system must be developed using existing proven equipment and must be readily available from inventory of the controls manufacturer or vendor at the time of bid.
- B. Native BACnet System Manufacturer must have at a minimum 50 operating projects utilizing the proposed native BACnet System. Provide 10 references of similar projects (include project name, contact, phone number, location, consultant, value of contract, and a brief description of the control system and how it operates) and submit 45 days prior to bid for review process.
- C. All controllers used on project must be of regular manufacturer and be readily available from inventory of the BACnet System Manufacturer.

- D. Provide standard components, of regular manufacture for this application for all materials and equipment. All systems and components shall have been thoroughly tested and proven in actual use.
- E. Operator workstation, if specified shall utilize Microsoft Windows 7 Professional or newer. All workstations and controllers shall be native BACnet devices. No 3rd party gateways shall be used for communication to controllers installed under this section.
- F. Provide all necessary BACnet-compliant hardware and software to meet the system's functional specifications. Provide Protocol Implementation Conformance Statement (PICS) for Windows-based control software and every controller in the system.
- G. All BACnet based peer-to-peer controllers, central system controllers and local user displays shall be UL listed under Standard UL 916, category PAZX.
- H. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Governing Radio Frequency Electromagnetic Interference and be so labeled.

1.6 EMS SYSTEM CONTRACTOR QUALITY ASSURANCE

- A. Responsibility: All work described in this section shall be engineered, installed, wired, circuit tested calibrated and programmed by regularly employed control system engineers and electricians and technicians of the authorized temperature control system factory representative or branch office of the listed approved manufacturer. System Engineering, Programming and Installation shall not be subcontracted. The supplier of the BACnet Temperature Control and Energy Management System shall be responsible for inspection and Quality Assurance (QA) for all materials and workmanship furnished by him. Contractor must have a valid C-10 and C-20 license to bid this project.
- B. Component Testing and Availability: Maximum reliability shall be achieved through extensive use of high-quality, pre-tested components. The manufacturer prior to shipment shall individually test each and every controller, sensor, and all other DDC components. EMS System Contractor or Manufacturer must certify that any DDC part can be replaced within 5 working days.
- C. Unacceptable Bids: Bids by wholesalers, parts distributors, contractors or franchised dealers or any firm whose principal business is not that of installing automatic temperature control systems shall not be acceptable.
- D. Experience: Energy Management System Contractor (EMSC) shall have been in business and licensed by the State of California for a minimum of five continuous years prior to this project bid. EMSC must have been a factory authorized representative for a minimum of five years of the contractors proposed manufacturer's products and systems.
- E. EMSC must have performed, from an office not more than 100 miles from project site at least 25 projects, each of which included the installation of not less than 250 hardware I/O points, using the contractors proposed manufacturer's products and systems. Five of the 25 projects must have included the installation of not less than 1,500 hardware I/O points using the contractors proposed manufacturer's products and systems.
- F. EMSC shall have on staff a full time Mechanical Engineer that is a licensed Professional Engineer by the State of California, having not less than four years experience with the contractors proposed manufacturer's products and systems.
- G. EMSC shall have on staff a full time Applications Engineer and Control System Programmer, having not less than three years experience with the contractors proposed manufacturer's products and systems.

- H. EMSC shall have on staff a minimum of three full time control technicians, Senior control technician shall have not less than three years experience, junior technicians shall have not less than one years experience with the contractors proposed manufacturer's products and systems.
- I. EMSC shall have a full time service department with service available 24 hours a day, seven days a week. Service department will have been established for a minimum of five years and be staffed with factory trained and authorized service technicians capable of servicing all aspects of the control systems depicted on these plans.
- J. Service department shall have on staff a full time control system telephone support technician available during normal business hours dedicated to taking customer support calls and having the ability to call the project site and perform on-line diagnostics.
- K. EMSC shall assign an in-house project manager to provide a detailed project design and installation schedule with time markings and details for hardware items and software development phases. Schedule shall show all the target dates for transmission of project information and documents and shall indicate timing and dates for system installation, debugging, and commissioning.
- L. EMSC shall field verify existing controls that are to be reconnected to control system prior to design, submittal, and installation of work of this section. Notify Architect immediately of any discrepancies between field conditions and Work shown in the Contract Documents.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. BACNet-based Direct Digital Control System: Acceptable Manufacturers, as listed below and meeting the criteria and requirements specified herein, will be acceptable:
 - 1. Johnson Metasys (Basis of Design)
 - 2. Alerton.
 - 3. Siemens.
 - 4. For manufacturers/products not listed, products must meet all requirements herein and comply with substitution requirements in Division 01.

2.2 OPERATOR'S WORKSTATION (Locate in Mechanical Room)

- A. General structure of workstation interaction shall be a standard client/server relationship. Server shall be used to archive data and store system database. Clients shall access server for all archived data. Each client shall include flexibility to access graphics from server or local drive. Server shall support a minimum of 50 clients simultaneously.
- B. BACnet Conformance
 - 1. 1. Operator's workstation shall as a minimum support Point-to-Point (PTP) and Ethernet BACnet LAN types. It shall communicate directly via these BACnet LANs as a native BACnet device. Operator's terminal shall comply with the requirements of a BACnet conformance class 3 device and support all BACnet services necessary to provide the following BACnet functional groups:
 - a. Clock Functional Group
 - b. Event Response Functional Group
 - c. Time Master Functional Group

d. Device Communications

2. 2. Please refer to section 22.2, BACnet Functional Groups, in the BACnet standard for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All proprietary services, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.
3. 3. Standard BACnet object types accessed by the workstation shall include as a minimum: Analog Value, Analog Input, Analog Output, Binary Value, Binary Input, Binary Output, Calendar, Device, Event Enrollment, File, Notification Class, Program and Schedule object types. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.
4. 4. The Operator Workstation shall comply with Annex J of the BACnet specification for IP connections. This device shall use Ethernet to connect to the IP internetwork, while using the same Ethernet LAN for non-IP communications to other BACnet devices on the LAN. Must support interoperability on wide area networks (WANs) and campus area networks (CANs). Workstation shall support Foreign Device Registration to allow temporary workstation connection to IP network.

C. Displays

1. Operator's workstation shall display all data associated with project as called out on drawings and/or object type list supplied. Graphic background files shall be created using AutoCAD background files. System shall be capable of displaying graphic file, text, and dynamic object data together on each display and shall include animation. Information shall be labeled with descriptors and shall be shown with the appropriate engineering units. All information on any display shall be dynamically updated without any action by the user. Workstation shall allow user to change all field-resident BACnet System functions associated with the project, such as setpoints, weekly schedules, exception schedules, etc. from any screen no matter if that screen shows all text or a complete graphic display. This shall be done without any reference to object addresses or other numeric/mnemonic indications.
2. All displays and programming shall be generated and customized by the local BACnet System supplier and installer. Systems requiring factory development of graphics or programming of DDC logic are specifically prohibited.
3. Binary objects shall be displayed as ACTIVE/INACTIVE/NULL or with customized text. System shall be supplied with a library of standard graphics, which may be used unaltered or modified by the operator. Systems that do not allow customization or creation of new graphic objects by the operator (or with third-party software) shall not be allowed.
4. Analog objects shall be displayed with operator modifiable units. Analog input objects may also be displayed as individual graphic items on the display screen as an overlay to the system graphic. Pressing the button on the right side of the analog object spinner box allows direct entry of an analog value and accesses various menus where the analog value may be used, such as trend logs.
5. A mouse shall be used to move the pointer arrow to the desired item for selection of new display or to allow the operator to make changes to object data.

D. Password Protection

1. Provide security system that prevents unauthorized use unless operator is logged on. Access shall be limited to operator's assigned functions when user is logged on.
2. Each operator's terminal shall provide security for 200 users minimum. Each user shall have an individual User ID, User Name and Password. Entries are alphanumeric

characters only and are case sensitive (except for User ID). User ID shall be 0–8 characters, User Name shall be 0–29 characters, and Password shall be 4–8 characters long. Each system user shall be allowed individual assignment of only those control functions and menu items to which that user requires access. All passwords, user names, and access assignments shall be adjustable online at the operator’s terminal. Each user shall also have a set security level, which defines access to displays and individual objects the user may control. System shall include 10 separate and distinct security levels.

3. System shall include an Auto Logout Feature that shall automatically logout user when there has been no keyboard or mouse activity for a set period of time. Time period shall be adjustable by system administrator.

E. Operator Activity Log

1. Operator Activity Log shall be included with system that tracks all operator changes and activities. System shall track what is changed in the system, who performed this change, date and time of system activity and value of the change before and after operator activity. Operator shall be able to display all activity, sort the changes by user and also by operation.
2. Log shall be gathered and archived to hard drive on operator workstation as needed. Operator shall be able to export data for display and sorting in a spreadsheet.
3. Any displayed data, that is changeable by the operator, may be selected using the right mouse button and the operator activity log shall then be selectable on the screen. Selection of the operator activity log using this method shall show all operator changes of just that displayed data.

F. Scheduling

1. Operator’s workstation shall show all information in easy-to-read daily format including calendar of this month and next. All schedules shall show actual ON/OFF times for day based on scheduling priority. Priority for scheduling shall be events, holidays and daily with events being the highest.
2. Holiday and special event schedules shall display data in calendar format. Operator shall be able to schedule holidays and special events directly from these calendars.
3. Operator shall be able to change all information for a given weekly or exception schedule if logged on with the appropriate security access.
4. System shall include a Schedule Wizard for set up of schedules. Wizard shall walk user through all steps necessary for schedule generation. Wizard shall have its own pull-down selection for startup or may be started by right clicking on value displayed on graphic and then selecting Schedule.

G. Alarm Indication and Handling.

1. Operator’s workstation shall provide audible, visual, and printed means of alarm indication. The alarm dialog box shall always become the top dialog box regardless of the application(s), currently running. Printout of alarms shall be sent to the assigned terminal and port.
2. System shall provide log of alarm messages. Alarm log shall be archived to the hard disk of the system operator’s terminal. Each entry shall include a description of the event-initiating object generating the alarm. Description shall be an alarm message of at least 256 characters in length. Entry shall include time and date of alarm occurrence, time and date of object state return to normal, time and date of alarm acknowledgment and identification of operator acknowledging alarm .

3. Alarm messages shall be in user-definable text (English or other specified language) and shall be entered either at the operator's terminal or via remote communication.

H. Trend log Information

1. System server shall periodically gather historically recorded data stored in the building controllers and archive the information. Archived files shall be appended with new sample data, allowing samples to be accumulated. Systems that write over archived data shall not be allowed, unless limited file size is specified. Samples may be viewed at the operator's workstation. Operator shall be able to scroll through all trended data. All trend log information shall be displayed in standard engineering units.
2. Software shall be included that is capable of graphing the trend logged object data. Software shall be capable of creating two-axis (x,y) graphs that display up to ten object types at the same time in different colors. Graphs shall show object values relative to time.
3. Operator shall be able to change trend log setup information. This includes the information to be logged as well as the interval at which it is to be logged. All input, output, and value object types in the system may be logged. All operations shall be password protected. Setup and viewing may be accessed directly from any and all graphics on which object is displayed.

I. Demand Limiting

1. System shall include demand limiting program that includes two types of load shedding. One type of load shedding shall shed/restore equipment in binary fashion based on energy usage when compared to shed and restore settings. The other type of shedding shall adjust operator selected control setpoints in an analog fashion based on energy usage when compared to shed and restore settings. Shedding may be implemented independently on each and every zone or piece of equipment connected to system.
2. Binary shedding shall include minimum of 5 priority levels of equipment shedding. All loads in a given priority level shall be shed before any loads in a higher priority level are shed. Load shedding within a given priority level shall include two methods. In one the loads shall be shed/restored in a "first off-first on" mode and in the other the loads are just shed/restored in a linear fashion.
3. Analog shed program shall generate a ramp that is independently used by each individual zone or individual control algorithm to raise the appropriate cooling setting and lower appropriate heating setting to reduce energy usage.
4. Status of each and every load shed program shall be capable of being displayed on every operator terminal connected to system. Status of each load assigned to an individual shed program shall be displayed along with English description of each load.
 - a. Property management information
 - b. Overall billing rate
 - c. Seasonal adjustments or surcharge to billing rate
 - d. Billing notification type such including, but not limited to printer, file and email
 - e. Billing form template
5. Logging shall include recording the following information for each and every tenant event.
 - a. Zone description
 - b. Time the event begins
 - c. Total override time
 - d. Limits shall be applied to override time.

6. A tenant bill shall be generated for a specific period using all the entered configuration data and the logged data. User with appropriate security level shall be able to view and override billing information. User shall be able to select a billing period to look to view and be able to delete events from billing and be able to edit a selected tenant activity event's override time.
- J. Configuration/Setup
1. Provide means for operator to display and change system configuration. This shall include, but not be limited to, system time, day of the week, date of daylight savings set forward/set back, printer termination, port addresses, modem port and speed, etc. Items shall be modified using understandable terminology with simple mouse/cursor key movements.
- K. Field Engineering Tools
1. Operator's workstation software shall include field-engineering tools for programming all controllers supplied. All controllers shall be programmed using graphical tools that allow the user to connect function blocks on screen that provide sequencing of all control logic. Function blocks shall be represented by graphical displays that are easily identified and distinct from other types of blocks. Graphical programming that uses simple rectangles and squares is not acceptable.
 2. User shall be able to pick graphical function block from menu and place on screen. Provide zoom in and zoom out capabilities. Function blocks shall be downloaded to controller without any reentry of data.
 3. Programming tools shall include a real time operation mode. Function blocks shall display real time data and be animated to show status of data inputs and outputs when in real time operation. Animation shall show change of status on logic devices and countdown of timer devices in graphical format.
 4. Field engineering tools shall also include a database manager of applications that include logic files for controllers and associated graphics. Operator shall be able to select unit type, input/output configuration and other items that define unit to be controlled. Supply minimum of 250 applications as part of workstation software.
 5. Field engineering tool shall include Device Manager for automatic detection of devices connected anywhere on the BACnet network by scanning of the entire network. This function shall display device instance, network identification, model number and description of connected devices. It shall record and display software file loaded into each controller. A copy of each file shall be stored on the computers hard drive. If needed, this file shall be downloaded to the appropriate controller by selection using the mouse.
 6. System shall include backup/restore function that will back up entire system to selected medium and then restore system from that media.
- L. Software
1. At the conclusion of project, contractor shall leave with owner a CD ROM that includes the complete software operation system and project graphics, setpoints, system parameters, etc. This backup shall allow the owner to completely restore the system in the case of a computer malfunction.

2.3 Web Interface (New ENTERPRISE SOFTWARE)

- A. General – BACnet System supplier shall provide web-based access to the system as part of standard installation USING html-5. User shall be able to access all displays of real-time data that are part of the BACnet System via a standard Web browser. Web browser shall tie into the network via owner-supplied Ethernet network connection. Web-page host shall be a

separate device that resides on the BACnet network, but is not the BACnet System Server for the control system. BACnet System Server must be a separate computer from the Web-page host device to ensure data and system integrity. The web-page software shall not require a per user licensing fee or annual fees. The web-page host must be able to support on average 50 simultaneous users with the ability to expand the system to accommodate an unlimited number of users.

- B. Browser Technology - Browser shall be standard version of Microsoft IE 5.5 or later and Netscape Navigator 4.76 or later. No special vendor-supplied software shall be needed on computers running browser. All displays shall be viewable and the Web-page host shall directly access real-time data from the BACnet network. Data shall be displayed in real time and update automatically without user interaction. User shall be able to change data on displays if logged in with the appropriate user name and password.
- C. Communications
 - 1. Web-page host shall include two Ethernet network connections. One network connection shall be dedicated to BACnet network and shall be used to gather real-time data from all the BACnet devices that form the BACnet System. This network shall communicate via BACnet, allowing the Web-page host to gather data directly from units on the local LAN or from other projects connected over a WAN. This network shall also provide the connection to the BACnet server for Web page generation.
 - 2. The second Ethernet connection shall provide the physical connection to the Internet or an IP-based WAN. It shall be the port that is used for the browser to receive Web pages and data from the Web-page host. The Web-page host shall act as a physical barrier between the BACnet network and the WAN or Internet connection that allows the browser to receive web pages and data. The two separate network connections provide for a physical barrier to prevent raw BACnet traffic being exposed on the IP network.
 - 3. The Web-page host shall provide for complete isolation of the IP and BACnet networks by not routing networking packets between the two networks.
 - 4. BACnet Ethernet network shall be provided and installed by the BACnet System supplier. Owner shall provide and incur any monthly charges of WAN/Internet connection.
- D. Display of Data
 - 1. Web page graphics shown on browser shall be replicas of the BACnet System displays. User shall need no additional training to understand information presented on Web pages when compared to what is shown on BACnet System displays. Web page displays shall include animation just as BACnet System displays. Fans shall turn, pilot lights shall blink, and coils shall change colors, and so on.
 - 2. Real-time data shall be shown on all browser Web pages. This data must be directly gathered via the BACnet network and automatically updated on browser Web page displays without any user action. Data on the browser shall automatically refresh as changes are detected without re-drawing the complete display.
 - 3. It shall be possible for user from browser Web page to change data if the user is logged on with the appropriate password. Clicking on a button or typing in a new value shall change digital data. Using pull-down menus or typing in a new value shall change analog data.
 - 4. Data displays shall be navigated using pushbuttons on the displays that are simply clicked on with the mouse to select a new display. Alternatively, the standard back and forward buttons of the browser can be used for display navigation.
- E. Time Schedule Adjustment

1. Web access shall allow user to view and edit all schedules in the system. This includes standard, holiday and event schedules as described in BACnet System specification. Display of schedules shall show interaction of all schedules on a single display so user sees an overview of how all work together. User shall be able to edit schedules from this display.
 2. Display of all 3 schedules must show all ON times for standard, holiday and event schedules in different colors on a given day. In addition, OFF times for each must also be shown in additional colors. User shall be able to select from standard calendar what days are to be scheduled and same display shall show all points and zones affected. User shall be able to set time for one day and select all days of the week that shall be affected as a recurrence of that same schedule for that given day.
 3. Schedule list shall show all schedules currently defined. This list shall include all standard, holiday and event schedules. In addition, user shall be able to select a list that shows all scheduled points and zones.
- F. Logging of Information
1. User shall use standard browser technology to view all trend logs in system. User shall be able to view logged data in tabular form or graphical format. User shall be able to adjust time interval of logged data viewed and shall be able to adjust y axis of data viewed in graphical format. User shall also be able to down-load data through the web interface to local computer. Data shall be in CSV format.
- G. Alarm Handling
1. Web interface shall display alarms as they occur. User shall be able to acknowledge alarms using browser technology. In addition, user shall be able to view history of alarm occurrence over a user selected time frame. In addition, those alarms may be filtered for viewing per user selected options. A single selection shall display all alarms that have not been acknowledged.
- H. Web Page Generation
1. Web pages shall be generated automatically from the BACnet System displays that reside on the BACnet System server. User shall access Web-page host via the network and shall initiate a web page generation utility that automatically takes the BACnet System displays and turns them into Web pages. The Web pages generated are automatically installed on the Web page host for access via any computer's standard browser.
- I. Password Security and Activity Log
1. Access via Web browser shall utilize the same hierarchical security scheme as BACnet System system. User shall be asked to log in once the browser makes connection to Web-page host. Once the user logs in, any and all changes that are made shall be tracked by the BACnet System server. The user shall be able to change only those items that the user has authority to change. A user activity report shall show any and all activity of the users that have logged in to the system regardless of whether those changes were made using a browser or via the BACnet System workstation.
- J. BACnet Communication
1. Web server shall directly communicate to all devices on the BACnet System network using BACnet protocol. No intermediate devices shall be necessary for BACnet communication.

2.4 BUILDING CONTROLLER (ACM)

A. General Requirements

1. Building Controller shall be of modular construction such that various modules may be selected to fit the specific requirements of a given project. Modules shall consist of a power supply module, a BACnet Ethernet-MS/TP module, a BACnet MS/TP only module and a modem module for telephone communication as a minimum. Those projects that require special interfaces may use Modbus modules as needed. However, all Ethernet communications and all controllers including central plant controllers, advanced application controllers and unitary controllers supplied by BMS manufacturer shall utilize the BACnet protocol standard.
2. Modules shall be selected to fit the particular project application. Up to 7 modules shall be powered by a single power supply module. All modules shall be panel mounted on DIN rail for ease of addition and shall be interconnected via simple plug in cable. A module in the middle shall be replacable without removing any other modules.
3. All modules shall be capable of providing global control strategies for the system based on information from any objects in the system regardless if the object is directly monitored by the building controller module or by another controller. The software program implementing these strategies shall be completely flexible and user definable. All software tools necessary for programming shall be provided as part of project software. Any systems utilizing factory pre-programmed global strategies that cannot be modified by field personnel on-site, via a wide area network or downloaded via remote communications are not acceptable. Changing global strategies via firmware changes is also unacceptable.
4. Programming shall be object-oriented using control function blocks, supporting DDC functions, 1000 Analog Values and 1000 Binary Values. All flowcharts shall be generated and automatically downloaded to controller. Programming tool shall be supplied and be resident on workstation. The same tool shall be used for all controllers.
5. Provide means to graphically view inputs and outputs to each program block in real-time as program is executing. This function may be performed via the operator's workstation or field computer.
6. Controller shall have a memory needed to ensure high performance and data reliability. Battery shall provide power for orderly shutdown of controller and storage of data in nonvolatile flash memory. Battery back up shall maintain real-time clock functions for a minimum of 20 days.
7. Global control algorithms and automated control functions shall execute via 32-bit processor.
8. Schedules
 - a. Each building controller module shall support a minimum of 80 BACnet Schedule Objects and 80 BACnet Calendar Objects.
 - b. Building controller modules shall provide normal 7 day scheduling, holiday scheduling and event scheduling.
9. Logging Capabilities
 - a. Each building controller shall log as minimum 320 values. Any object in the system (real or calculated) may be logged. Sample time interval shall be adjustable at the operator's workstation.
 - b. Logs may be viewed both on-site or off-site via WAN or remote communication.
 - c. Building controller shall periodically upload trended data to networked operator's workstation for long term archiving if desired.
 - d. Archived data stored in database format shall be available for use in third-party spreadsheet or database programs.
10. Alarm Generation

- a. Alarms may be generated within the system for any object change of value or state either real or calculated. This includes things such as analog object value changes, binary object state changes, and various controller communication failures.
 - b. Each alarm may be dialed out as noted elsewhere.
 - c. Alarm log shall be provided for alarm viewing. Log may be viewed on-site at the operator's terminal or off-site via remote communications.
 - d. Controller must be able to handle up to 320 alarm setups stored as BACnet event enrollment objects – system destination and actions individually configurable.
11. Demand Limiting
- a. Demand limiting of energy shall be built a built in function that shall be user configurable. Each controller module shall support shedding of up to 200 loads using a minimum of two types of shed programs.
 - b. Load shedding programs in Building Controller Modules shall operate as defined in section 2.1.J of this specification.
12. Tenant Activity Logging
- a. Tenant Activity logging shall be supported by Building Controller Module. Each independent module shall support a minimum of 80 zones.
 - b. Tenant Activity logging shall functions as defined in section 2.1.K of this specification.
13. Automatic Demand Response (ADR)
- a. Software shall have imbedded ADR strategies that the District can employ at any time.
14. Title 24 FDD Economizer Control
- a. The controller software shall incorporate a CEC (California Energy Commission) listed and approved FDD economizer control strategy.
- B. Ethernet – MS/TP Module
1. Ethernet – MS/TP Module shall support every function as listed under paragraph A, General Requirements, of this section and the following.
 2. All communication with operator workstation and all application controllers shall be via BACnet. Building controller Ethernet – MS/TP module shall incorporate as a minimum, the functions of a 2-way BACnet router. Controller shall route BACnet messages between the high-speed LAN (Ethernet 10/100MHz) and master slave token passing (MS/TP) LAN. Ethernet – MS/TP module shall also route messages from all other Building Controller modules onto the BACnet Ethernet network.
 - a. MS/TP LAN must be software configurable from 9.6 to 76.8Kbps.
 - b. The RJ-45 Ethernet connection must accept either 10Base-T or 100Base-TX BACnet over twisted pair cable (UTP).
 3. BACnet Conformance
 - a. Ethernet – MS/TP module shall as a minimum support MS/TP and Ethernet BACnet LAN types. It shall communicate directly via these BACnet LANs as a native BACnet device and shall support simultaneous routing functions between all supported LAN types. Global Controller shall be a BACnet conformance class 3 device and support all BACnet services, Functional Groups and all standard BACnet object types
 - b. The Building Controller shall comply with Annex J of the BACnet specification for IP connections. This device shall use Ethernet to connect to the IP internetwork, while using the same Ethernet LAN for non-IP communications to other BACnet devices on the LAN. Must support interoperability on wide area networks (WANs) and campus

area networks (CANs) and function as a BACnet Broadcast Management Device (BBMD).

2.5 Visual Logic CONTROLLERS (VLC)

- A. Provide one or more native BACnet application controllers for each air handler and or Fan coil unit. All controllers shall interface to building controller via MS/TP LAN using BACnet protocol. No gateways shall be used. Controllers shall include input, output and self-contained logic program as needed for complete control of units. Controllers shall be fully programmable using graphical programming blocks. Programming tool shall be resident on operator workstation and be the same tool as used for the building controller. No auxiliary or non-BACnet controllers shall be used.
- B. BACnet Conformance
 - 1. Application controllers shall as a minimum support MS/TP BACnet LAN types. They shall communicate directly via this BACnet LAN at 9.6, 19.2, 38.4 and 76.8 Kbps, as native BACnet devices. Application controllers shall be of BACnet conformance class 3 and support all BACnet services necessary such as Files Functional Group, Reinitialize Functional Group and Device Communications Functional Group.
 - 2. Please refer to section 22.2, BACnet Functional Groups, in the BACnet standard, for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All proprietary services, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.
 - 3. Standard BACnet object types supported shall include as a minimum—Analog Input, Analog Output, Analog Value, Binary Input, Binary Output, Binary Value, Device, File, and Program object types. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.
- C. Application controllers shall include universal inputs with 10-bit resolution that accept 3K and 10K thermistors, 0–10VDC, 0–5 VDC, 4–20 mA and dry contact signals. Any input on a controller may be either analog or digital with a minimum of 3 inputs that accept pulses. Controller shall also include support and modifiable programming for interface to intelligent room sensor with digital display. Controller shall include binary and analog outputs on board. Analog outputs shall be switch selectable as either 0–10VDC or 0–20mA. Software shall include scaling features for analog outputs. Application controller shall include 24VDC voltage supply for use as power supply to external sensors.
- D. All program sequences shall be stored on board application controller in EEPROM. No batteries shall be needed to retain logic program. All program sequences shall be executed by controller 10 times per second and capable of multiple PID loops for control of multiple devices. All calculations shall be completed using floating-point math and system shall support display of all information in floating-point nomenclature at operator's terminal. Programming of application controller shall be completely modifiable in the field over installed BACnet LANs or remotely via modem interface. Operator shall program logic sequences by graphically moving function blocks on screen and tying blocks together on screen. Application controller shall be programmed using programming tools as described in operator's terminal section.
- E. Application controller shall include support for intelligent room sensor. Display on intelligent room sensor shall be programmable at application controller and include an operating mode and a field service mode. All button functions and display data shall be programmable to show specific controller data in each mode based on which button is pressed on the sensor. See sequence of operation for specific display requirements at intelligent room sensor.

2.6 APPLICATION SPECIFIC VLC CONTROLLERS (HP's, AC's, FC's)

- A. Provide one native BACnet application controller for each piece of unitary mechanical equipment that adequately covers all objects listed in object list for unit. All controllers shall interface to building controller via MS/TP LAN using BACnet protocol. No gateways shall be used. Controllers shall include input, output and self-contained logic program as needed for complete control of unit.
- B. BACnet Conformance
 - 1. Application controllers shall as a minimum support MS/TP BACnet LAN types. They shall communicate directly via this BACnet LAN at 9.6, 19.2, 38.4 and 76.8 Kbps, as native BACnet devices. Application controllers shall be of BACnet conformance class 3 and support all BACnet services necessary such as Files Functional Group, Reinitialize Functional Group and Device Communications Functional Group.
 - 2. Please refer to section 22.2, BACnet Functional Groups in the BACnet standard for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All proprietary services, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.
 - 3. Standard BACnet object types supported shall include as a minimum—Analog Input, Analog Output, Analog Value, Binary Input, Binary Output, Binary Value, Device, File and Program Object Types. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.
- C. Application controllers shall include universal inputs with 10-bit resolution that can accept 3K and 10K thermistors, 0–5 VDC, 4–20 mA, dry contact signals and a minimum of 3 pulse inputs. Any input on controller may be either analog or digital. Controller shall also include support and modifiable programming for interface to intelligent room sensor. Controller shall include binary outputs on board with analog outputs as needed.
- D. All program sequences shall be stored on board controller in EEPROM. No batteries shall be needed to retain logic program. All program sequences shall be executed by controller 10 times per second and shall be capable of multiple PID loops for control of multiple devices. Programming of application controller shall be completely modifiable in the field over installed BACnet LANs or remotely via modem interface. Operator shall program logic sequences by graphically moving function blocks on screen and tying blocks together on screen. Application controller shall be programmed using same programming tools as building controller and as described in operator workstation section. All programming tools shall be provided and installed as part of system.
- E. Application controller shall include support for intelligent room sensor. Display on room sensor shall be programmable at controller and include an operating mode and a field service mode. All button functions and display data shall be programmable to show specific controller data in each mode based on which button is pressed on the sensor. See sequence of operation for specific display requirements at intelligent room sensor.

2.7 SENSORS and MISCELLANEOUS DEVICES

- A. Temperature Sensors
 - 1. All temperature sensors to be solid state electronic, factory-calibrated to within 0.5°F, totally interchangeable with housing appropriate for application. Wall sensors to be installed as indicated on drawings. Mount 48 inches about finished floor. Duct sensors to be installed such that the sensing element is in the main air stream. Immersion sensors to be installed in wells provided by control contractor, but installed by mechanical

contractor. Immersion wells shall be filled with thermal compound before installation of immersion sensors. Outside air sensors shall be installed away from exhaust or relief vents, not in an outside air intake and in a location that is in the shade most of the day.

- B. Intelligent Room Sensor with LCD Readout – Microset 4 (Temperature, Humidity)
 - 1. Sensor shall contain a backlit LCD digital display and user function keys along with temperature sensor. Controller shall function as room control unit, and shall allow occupant to raise and lower setpoint, and activate terminal unit for override use—all within limits as programmed by building operator. Sensor shall also allow service technician access to hidden functions as described in sequence of operation.
 - 2. The Intelligent Room Sensor shall simultaneously display room setpoint, room temperature, outside temperature, and fan status (if applicable) at each controller. This unit shall be programmable, allowing site developers the flexibility to configure the display to match their application. The site developer should be able to program the unit to display time-of-day, room humidity and outdoor humidity. Unit must have the capability to show temperatures in Fahrenheit or Centigrade.
 - 3. Override time may be set and viewed in half-hour increments. Override time count down shall be automatic, but may be reset to zero by occupant from the sensor. Time remaining shall be displayed. Display shall show the word “OFF” in unoccupied mode unless a function button is pressed.
 - 4. See sequence of operation for specific operation of LCD displays and function keys in field service mode and in normal occupant mode. Provide intelligent room sensors as specified in point list.
 - 5. Space sensor shall have a soft light glow beneath the space sensor that glows Blue when the AC unit is in cooling, ORANGE when in heating and RED if the FDD economizer controls detect a fault.
- C. Microtouch Wall Sensor (If shown on drawings)
 - 1. Standard wall sensor shall use solid-state sensor identical to intelligent room sensor and shall be packaged in aesthetically pleasing enclosure. Sensor shall provide override function, warmer/cooler lever for set point adjustment and port for plug-in of Field Service Tool for field adjustments. Override time shall be stored in controller and be adjustable on a zone-by-zone basis. Adjustment range for warmer/cooler lever shall also be stored in EEPROM on controller. All programmable variables shall be available to Field Service Tool through wall sensor port.
- D. Blank Stainless Steel Wall Sensor (If shown on drawings)
 - 1. Blank stainless steel room sensor shall use solid-state sensor identical to intelligent room sensor.
 - 2. Dorm room AC units shall have return air temperature sensors installed in the chase behind the return air grills of the dorm rooms.

PART 3 - EXECUTION

3.1 GENERAL

- A. All electric wiring and all installation work including piping of control systems and internal wiring of panelboards for temperature control and indicating systems shall be done by an authorized representative of the controls manufacturer whose primary business is the installation and maintenance of temperature control and indicating systems. Wiring shall conform to National Electric Code.

- B. Identify each item of control equipment with stamped tape firmly attached to equipment and each panel with nameplate of 1/16 inch laminated plastic with black background and white letters 1/4 inch high.
- C. Control system shall be connected to the existing systems. All control adjustments shall be accessible without use of ladder.
- D. Thermostats on outside walls shall be mounted on 1 inch rigid fiberglass insulating base.
- E. Drawings:
 - 1. Drawings are diagrammatic only, provide all material and labor required to make the system operate to the complete satisfaction of the Architect at no additional cost to the Owner.
 - 2. Submit to the Architect for approval seven copies of shop drawings of the entire control system before starting work.
 - 3. Upon completion of the work, provide diagrams of the control systems including a detailed description of the operation of the system and each component and post in the mechanical room, or as directed in a permanent frame with 1/8 inch clear plastic cover.
- F. There shall be no power wiring in excess of 40 VAC peak voltages run in conduit with communications trunk wiring. In cases where power or signal wiring is run in conduit with trunk wiring, all communication trunk wiring and power wiring shall be run using separate twisted shielded pairs (24 awg) with the shields grounded in accordance with the manufacturers wiring practices.

3.2 INSTALLATION

- A. All temperature control and control interlock wiring shall be installed in EMT conduit per local code unless otherwise noted on the plans. Open Plenum wire may be used above accessible ceiling.
- B. Wiring shall conform to the California Electrical Code.
- C. The installation and supervision of this project shall be carried out by factory-trained personnel who are employed by the Contractor and licensed for this type of work.
- D. Install in accordance with manufacturer's instructions.
- E. Provide all miscellaneous devices, hardware, software, interconnections installation and programming required to insure a complete operating system in accordance with the sequences of operation and point schedules.
- F. All wiring of any nature in connection with the Direct Digital Control and Temperature Control System, regardless of voltage, including temperature control wiring, interlocking branch circuits from power panels, line voltage to EMS devices and low voltage wiring unless shown or specified in Division 26 documents shall be included in this section.

3.3 OPERATOR INSTRUCTION (Training)

- A. During system commissioning and at such time acceptable performance of the control system hardware and software has been established; provide 16 hours of operator instruction to the Owner's operating personnel. Operator instruction during normal working hours shall be performed by a competent representative familiar with systems hardware, software and accessories.

- B. At a time mutually agreed upon during system commissioning, as stated above, provide 16 hours of instruction to the Owner's designated personnel on the operation of the EMS and Temperature Control Systems and describe its intended use with respect to the programmed functions specified. Operator orientation of the EMS shall include, but not be limited to, the overall operation of the program, equipment functions (both individually and as part of the total integrated system), commands, systems generation, advisories, and appropriate operator intervention required in responding to the system's operation.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Diesel fuel oil storage tanks, piping, and accessories; underground or aboveground as shown on contract drawings.
 - 2. Tank fluid level monitoring and alarm systems.
 - 3. Leak detection system for tanks and underground piping.
 - 4. Fuel oil quality maintenance system (water and particulate removal).

1.2 RELATED REQUIREMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 23 00 50, Basic HVAC Materials and Methods.
- C. Section 23 05 93, Testing, Adjusting, and Balancing for HVAC.
- D. Section 23 09 23, Direct Digital Control (DDC) System for HVAC.

1.3 ADDITIONAL REQUIREMENTS

- A. Furnish and install incidental work not shown or specified necessary to provide a complete and workable system.
- B. Make all temporary connections required to maintain services, including adequate heat and cooling, during the course of the Contract without additional cost to Owner. Notify Owner seven days in advance before disrupting services.
- C. Provide for adjustments or modifications to fan and motor sheaves, belts, damper linkages, and other components as required to achieve specified air balance at no additional cost to Owner.

1.4 REFERENCES AND STANDARDS

- A. Where material or equipment is specified to conform to referenced standards, it shall be assumed that the most recent edition of the standard in effect at the time of bid shall be used.
 - 1. NFPA: National Fire Protection Association.
 - a. NFPA 30: Flammable and Combustible Liquids Code.
 - b. NFPA 30A: Code for Motor Fuel Dispensing Facilities and Repair Garages.
 - c. NFPA 70: National Electrical Code.
 - 2. UL: Underwriters Laboratory.
 - a. UL 142: Standard for Steel Aboveground Tanks for Flammable and Combustible Liquids.
 - b. UL 2085: Standard for Protected Aboveground Tanks for Flammable and Combustible Liquids.
 - c. UL 87: Standard for Power-Operated Dispensing Devices for Petroleum Products.
 - 3. OSHA: Occupational Safety and Health Administration.
 - a. OSHA 29 CFR Part 1910.106: Flammable and Combustible Liquids.
 - 4. PEI: Petroleum Equipment Institute.

- a. PEI RP 300-13: Recommended Practices for Installation and Testing of Vapor Recovery Systems at Vehicle Fueling Sites.
- b. PEI 400-13: Recommended Procedures for Testing Electrical Continuity of Fuel-Dispensing.
- c. PEI RP 200-13: Recommended Practices for Installation of Aboveground Storage Systems for Motor Vehicle Fueling.

1.5 ACTION SUBMITTALS

- A. For additional requirements, refer to Section 23 00 50, Basic HVAC Materials and Methods.
- B. Manufacturer's Literature and Data including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.
- C. Aboveground Steel Tanks, Including Vault-type Tanks:
 1. Drawings of tanks, supports, ladders, platforms, heating coils, tank manholes, emergency relief vents and all accessories. Include overall dimensions and dimensional locations and sizes of pipe connections, and access openings.
 2. Recommended tank support locations.
 3. Weight of entire tank assembly, empty and flooded.
 4. Design and construction of primary tanks, insulation, secondary containment, supports, pipe connections, platforms.
 5. Application and performance data on coatings from manufacturer of coatings.
 6. Data certifying tanks are designed for surcharge loads of platforms shown.
 7. Certification of compliance with specified standards.
 8. Certification that steel tank manufacturer participates in Steel Tank Institute (STI) Quality Assurance Program.
 9. Design, construction, performance, dimensions of emergency relief vents.
- D. Fuel Piping:
 1. ASTM and UL compliance.
 2. Grade, class or type, schedule number.
 3. Manufacturer.
- E. Pipe Fittings, Unions, Flanges:
 1. ASTM and UL compliance.
 2. ASTM standards number.
 3. Catalog cuts.
 4. Pressure and temperature rating.
- F. Foot Valves, Check Valves, Overfill Prevention Valves:
 1. Catalog cuts showing design and construction.
 2. Pressure and temperature ratings.
 3. Pressure loss and flow rate data.
 4. Materials of construction.
 5. Accessories.
- G. Secondary Containment System for Fuel Piping:
 1. Sizes, materials, construction of containment system including end seals, sumps, coatings and pipe supports.
 2. Layout of system.
 3. Installation instructions.
 4. Design of cathodic protection system (steel casing).

- H. Leak Detection System:
 - 1. Drawings, description and performance data on sensors, control units.
 - 2. Description of operation.
 - 3. Layout of system.
 - 4. Installation and operating instructions.
 - 5. Data on interconnecting wiring systems to be furnished.

- I. Tank Fluid Level Monitoring Instrumentation System:
 - 1. Drawings showing instruments and in-tank sensing units, with dimensions.
 - 2. Design and construction of all elements of system.
 - 3. Installation instructions.

- J. Tank and Piping Accessories: Design, construction, and dimensions of vent caps, fill boxes, fill caps, spill containers and other accessories.

- K. Fuel Quality Maintenance System:
 - 1. Drawings and description of all components and arrangement of system.
 - 2. Design and performance of pumps, filters.
 - 3. Catalog data and operation of control system.
 - 4. Installation instructions.

1.6 CLOSEOUT SUBMITTALS

- A. Complete operating and maintenance manuals including wiring diagrams, technical data sheets, information for ordering replacement parts, and troubleshooting guide:
 - 1. Include complete list indicating all components of the systems.
 - 2. Include complete diagrams of the internal wiring for each item of equipment.
 - 3. Diagrams shall have their terminals identified to facilitate installation, operation and maintenance.

1.7 QUALITY ASSURANCE

- A. Approval of products or services of proposed manufacturers, suppliers and installers, and will be based on Contractor's certification that:
 - 1. Manufacturers regularly and currently manufacture tanks, tank and piping accessories, tank fluid level monitoring and leak detection systems, and fuel quality management systems.
 - 2. Manufacturers of steel tanks participate in the Quality Assurance Program of the Steel Tank Institute (STI).
 - 3. The design and size of each item of equipment provided for this project is of current production and has been in satisfactory operation on at least three installations for approximately three years. Current models of fluid level and leak detection systems with less than three years' service experience are acceptable if similar previous models from the same manufacturer have at least three years' service experience.

- B. Apply and install materials, equipment and specialties in accordance with manufacturer's written instructions. Conflicts between the manufacturer's instructions and the contract drawings and specifications shall be referred to the Architect for resolution. Provide copies of installation instructions to the Architect two weeks prior to commencing installation of any item.

- C. All equipment shall be free from defects that would adversely affect the performance, maintainability and appearance of individual components or overall assembly.

- D. Tanks, Secondary Containment Systems for Piping, Tank Level Monitoring Systems, Leak Detection Systems, Fuel Quality Management Systems: Authorized manufacturer's representatives shall provide onsite training of installers and supervision of the installation and testing of the equipment and systems to assure conformance to written instructions of manufacturers.
- E. Tank and piping installation contractor shall be certified as acceptable by local and state pollution control authorities.
- F. Entire installation shall conform to requirements of local and state pollution control authorities.
- G. Pipe Welding: Conform to requirements of ASME B31.1. Welders shall show evidence of qualification. Welders shall utilize a stamp to identify their work. Unqualified personnel will be rejected.
- H. All materials and products shall be new.

1.8 PERMITS

- A. Contractor shall obtain and complete all tank permit and registration forms required by governmental authorities.

1.9 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair storage tanks that fail in under the following conditions and within the warranty period.
 - 1. Covered failures include:
 - a. Release of stored product from any secondary containment tank.
 - b. Failure of primary tank caused by non-corrosion related cracking, breakup, or collapse.
 - c. Perforation of primary tank caused by internal corrosion as long as the product stored within the tank is compatible with steel.
 - 2. Warranty Period: 30 years from date of tank delivery.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Materials or equipment of the same type shall be of the same brand wherever possible. All materials shall be new and in first class condition.
- B. All sizes, capacities, and efficiency ratings shown are minimum.
- C. Refer to Division 22 10 00 and 23 80 00 for specific system piping materials.

2.2 ABOVEGROUND TANK SYSTEMS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Envirosafe Above-Ground Fuel Systems; Fireguard Tank.
 - 1. California Air Resources Board (CARB) Standing Loss Control testing requirements for air emissions.
 - 2. Steel Tank Institute (STI) Standard F941 for Thermally Insulated Above Ground Storage Tanks.

3. Description: UL 2085 ballistic and impact protection, double-wall, steel tank; with primary- and secondary-containment walls and insulated interstitial space.
- B. Basis-of-Design Product: Subject to compliance with requirements, provide Envirosafe Above-Ground Fuel Systems; Flameshield Tank.
1. Two-hour 2000 degree fire test, required by Southwest Research Institute Standard SwRI 97-04, validates performance of non-insulated tanks.
 2. Description: UL 142, double-wall, steel tank; with primary- and secondary- containment walls and interstitial space.
- C. Description:
1. Capacity: 1,000 gallons.
 2. Orientation: Horizontal
 3. Cross-section: Round
 4. Length: 1,000-G L 169" X W56" X H 78"
 5. Connection Sizes:
 - a. Fill Line: 4 inch (25 mm) Opening.
 - b. Vent Line: 2 inches (50 mm).
 6. Engineered hurricane tie-downs.
 7. Manway: 18 inches (457 mm) diameter; bolted, flanged, with gasket; centered on top of tank.
 8. Emergency Vent: 6 inches (152 mm).
 9. Stack Vent: 2 inches (50 mm) Mushroom Cap (12 feet above grade)
 10. Overspill Container: 7.5 gallons; 4 inches (100 mm) aluminum. Lockable with weld in drain to tank.
 11. 2 inch (50 mm) 818 Clock Gauge with standard float.
 12. Return Line: 1 inch (25 mm) return line fitting.
 13. 1.5 inch (38 mm) Pickup with drop tube and foot valve 6 inches (152 mm) from bottom of tank.
 14. Interstitial Leak Gauge.
 15. Fuel-Oil Grade Number: Diesel Use.
 16. Tank Decal Kit.
 17. Accessories:
 - a. Step ladder with platform welded onto tank
 18. Options
 - a. Morrison Bros 918 Clock Gauge with high level alarm
 - b. Morrison Bros 9095AA Overfill Prevention Valve
- D. FABRICATION
1. All weld seams to be joggled and sub arch welded.
 2. System must arrive turnkey from tank manufacturers facility.
- E. SHOP PAINTING OF AST
1. Prepare exterior steel surface of aboveground storage tank and tank supports.
 2. After cleaning, remove dust or residue from cleaned surfaces.
 3. If surface develops rust before prime coat is applied, repeat surface preparation.
 4. Apply manufacturer's one coat system (Envirolastic 940 DTM) to shop-cleaned, dry surface on the same day as surface preparation.

2.3 PIPING, VALVES, FITTINGS

- A. Fuel supply and return, tank fill, vents, sounding, and pump out.
- B. Steel Pipe and Fittings:

1. Piping: Steel, seamless or electric resistance welded (ERW), ASTM A53/A53M Grade B or ASTM A106/A106M Grade B, Schedule 40. Aboveground piping shall be painted. Refer to Section 09 91 00, PAINTING.
 2. Joints: Socket or butt-welded. Threaded joints are prohibited except at valves, unions and tank connections.
 3. Fittings:
 - a. Butt-welded joints: Steel, ASTM A234/A234M, Grade B, ASME B16.9, same schedule as adjoining pipe.
 - b. Socket-welded joints: Forged steel, ASME B16.11, 13,790 kPa (2000 psig) class.
 4. Unions: Malleable iron, 2070 kPa (300 psig) class.
 5. Companion flanges: Flanges and bolting, ASME B16.5.
 6. Welding flanges: Weld neck, ASME B16.5, forged steel ASTM A105/A105M, 1034 kPa (150 psig).
- C. Check Valves - Fuel Pump Suction.
1. Pipe Sizes 2 inches and under: Rated for 200 psig water-oil-gas, swing-type, threaded ends, ASTM B62 bronze body. Provide union adjacent to valve.
 2. Pipe Sizes 2 1/2 inches and above: Rated for 200 psig water-oil-gas, swing-type, 861 kPa (125 pounds) ASME flanged ends, ASTM A126 class B cast iron body.
- D. Foot Valves - Fuel Pump Suction: Double poppet, lapped-in metal-to-metal seats, double-guided stems, 20 mesh inlet screen, same size as fuel suction piping. Foot valve shall be removable to above grade through the tank manhole enclosure or through extractor fitting.
- E. Extractor Fittings: Arranged to permit removal of foot valves, overfill prevention valves, and other devices that are located below grade. Access point shall be through a cast iron fill box-type manhole located at grade. Provide extractor wrench.
- F. Overfill Prevention Valve: Aluminum automatic valve designed for underground or aboveground tanks, as applicable. Removable through the extractor fitting on underground tanks. Locate valve near the top of the tank in the fill pipe. On underground tanks with gravity fill, provide two stage automatic float-operated valve. First stage operation at 92 percent tank capacity shall reduce flow to 5 gpm or less. Second stage operation shall stop flow completely when tank is no more than 95 percent full. On aboveground tanks, or tanks pressure-filled, provide single stage valve, rated for fill flow and pressure, which stops flow completely at 95 percent of tank capacity. Valve shall include method for draining oil trapped above the valve into the tank.

2.4 TANK AND PIPING ACCESSORIES

- A. Vent Caps: Galvanized cast iron or cast aluminum with brass or bronze screens, arranged to permit full venting and to prevent entry of foreign material into the vent line. Same pipe size as vent pipe.
- B. Fill caps located above grade without fill boxes shall be lockable, tight-fill design, operated by special wrench that shall be furnished. Entire assembly shall seal tight with no leakage during fill and when cap is in place.
- C. Fill Point Identification:
1. Fill Caps above Grade: Aluminum, brass or bronze plate, clamped to fill pipe, with stamped or engraved letters 3/4 inch high.
 2. Legend: "DIESEL FUEL FILL"

2.5 LEAK DETECTION SYSTEMS

- A. Automatic digital continuous monitoring systems responsive to the presence of water and hydrocarbons in the interstitial space of the double-wall tanks, and in the secondary containment of fuel piping systems. System shall distinguish between hydrocarbon and water and identify location of leak as to tank and piping system.
 - 1. System may be combined with tank fluid level monitor and alarm system specified in paragraph, TANK FLUID LEVEL MONITOR AND ALARM SYSTEM.

- B. Functions and Arrangement:
 - 1. Single control station to monitor all sensing probes.
 - 2. Visual indicator to monitor and identify leaks as water or hydrocarbon and location.
 - 3. Indicators showing system status including faults and alarms.
 - 4. On board printer that provides complete reports of all system functions upon command.
 - 5. Panel circuit test button.
 - 6. 95 dB audible alarm with silencing control to sound when leak is detected.
 - 7. Eight-hour memory backup system with battery.
 - 8. NEMA 250 Type 4 cabinet.
 - 9. UL or other accredited testing laboratory listing.
 - 10. RS232 Modbus communications with engineering control system to indicate system in service and alarm conditions.

- C. Sensors:
 - 1. Designed for required locations including: Insertion between walls of double-wall tanks, in sumps in double-wall piping systems and in tank manhole enclosures. Sensing points shall be at lowest point of each tank or sump. Intrinsically safe design.
 - 2. Sensing units shall detect presence of water and a minimum 1/8 inch thick layer of hydrocarbon on surface of water and minimum 2 inch thickness of hydrocarbon in area that has no water present.
 - 3. Sensors shall be arranged to allow replacement of individual sensors without disturbing other portions of leak detection system or fuel storage and piping system. Underground sensors shall be accessed through caps as grade.
 - 4. Materials of construction shall be non-corroding.
 - 5. Transmit status signal to control unit.

2.6 TANK FLUID LEVEL MONITOR AND ALARM SYSTEMS

- A. Digital systems for central monitoring of fuel and water levels in all fuel oil storage tanks in the project. High and low level visual and audible alarms. Volumetric tank-tightness testing. Complete with all transducing, transmitting, and receiving devices. On board printer to provide complete report of all system functions upon command.
 - 1. System may be combined with leak detection system specified in paragraph, LEAK DETECTION SYSTEMS.

- B. Fluid Level Monitor:
 - 1. Digital continuous readout, showing tank oil and water levels in gallons, smallest reading one gallon. Provide identification of product measured, measuring units, and the tank number.
 - 2. Tank and fuel characteristics contained in preprogrammed non-volatile field-replaceable databases. Protected power supply.

- C. High and Low Fluid Level Alarm System:
 - 1. Automatic continuous on-line monitoring of all tanks.
 - 2. Visual and audible indicators combined with fluid level monitor. Identify the tank that is in alarm condition.

3. Manual alarm test and silencing controls.
 4. Low level alarm actuation adjustable 0-25 percent of tank capacity. High level alarm actuation adjustable 75-100 percent of tank capacity.
- D. Locate all indicators, selector switches, alarms on face of wall-mounted NEMA 250, Type 4 panel.
- E. Remote Alarm Annunciator:
1. Visual and audible high-level alarms adjacent to tank fill box locations. Locate in NEMA 250 Type 4X weatherproof exterior wall or pole-mounted panels.
 2. Alarm shall include flashing red light with 180-degree visibility for each tank and 95 dB horn or 100 mm (4 inch) diameter bell. Provide alarm silence control.
 3. Provide identification sign: "WHEN ALARM SOUNDS - FUEL TANK FILLED TO CAPACITY - DO NOT OVERFILL".
- F. Modbus communication to engineering control system to indicate tank fluid level and alarm conditions.
- G. System Performance: Accuracy plus or minus 2.5 mm (0.10 inch) of fluid height in inventory mode and 0.25 mm (0.01 inch) in leak detection mode. Automatic compensation for fluid temperature changes. Volumetric tank tightness sensitivity of 0.4 lph (0.1 gph).
- H. Sensors:
1. Provide sensor types such as magnetostrictive, capacitance, float, hydrostatic and other types as necessary for the applications.
 2. Apply in accordance with manufacturer's instructions with provisions for easy future replacement without need for excavation.
 3. Provide for each hydrostatic sensor a constant flow differential pressure regulator and transmitter protected from fuel contamination. Air supply shall include filter and over-pressure protection. Provide desiccant-type dryer on air supply designed for removal of water vapor. Dryer rating, minimum 4.6 L/s (10 SCFM). Provide moisture indicator. Dryer may be deleted if air supply source has a refrigerated dryer.
 4. Float-type units shall be designed for installation and removal through a 100 mm (4 inch) diameter vertical pipe mounted in the top of the tank.
- I. Code Conformance: NFPA 70.

2.7 FUEL OIL QUALITY MAINTENANCE SYSTEMS

- A. Complete factory-assembled automatic particulate filtration and dewatering system to maintain the purity of No. 2 fuel oil in storage. The system shall circulate the oil from the storage tank, through the system, and back to the storage tank. Provide quantity and capacity of systems to serve tanks as shown, connected to the tank suction and return pipes. Smaller systems without large water storage tanks and without fuel additive injection shall be wall-mounted. Digital controls.
- B. Description: Stand alone, factory complete, automated programmable, fuel filtration and maintenance system shall be provided for each diesel fuel storage tank to optimize and maintain the condition of fuel stored in that tank. The system shall be capable of eliminating microbial contamination and removing water, sediment, and particulate to comply with ASTM D975 (Standard Specification for Diesel Fuel Oils).

1. Enclosure: All system components shall be contained within a powder coated, weatherproof, outdoor UL 50 listed enclosure with appropriate ventilation. Hinged front door shall be equipped with quarter turn key lockable handle. Containment basin with leak detection sensor shall be installed. Literature pocket and brackets for wall or rack mounting to be included.
2. Plumbing: System shall be furnished with stainless steel shutoff ball valves on the inlet and outlet for easy filter/water separator maintenance. A flow indicator shall be installed to observe fuel flow and flow rate. Above mentioned components shall be located within the enclosure. Internal plumbing primarily stainless steel.
3. Installation: System shall provide male pipe connections protruding the enclosure for customer plumbing connection. System shall be located as close as possible to designated fuel tank. The fuel oil supply and return lines to the system shall be independent and separate from other fuel lines, with the supply line originating at the bottom of the tank in the deepest spot and the return line as far away as possible from the supply line within the tank.
4. Filtration/Water Separation: 4 stage filtration/water separation process:
 - a. Stage 1: Centrifugal water and particulate separation
 - b. Stage 2: Water collection (99.9% water removal) and 30 micron hydrophobic particulate filter element - with water detection sensor and "push and turn" safety drain valve
 - c. Stage 3: LG-X Fuel Conditioner – removes ferrous metals from fuel and breaks down sediments and solids naturally forming in diesel fuel to submicron levels
 - d. Stage 4: Secondary 3 Micron particulate and/or water adsorbing spin-on filter
5. Water Sensor: Watect Model 550 microcontroller-based water sensor alarm module.
6. Controls/Display Functions: System control features and indicator lights shall be located on the display panel of the Smart Filtration Controller for easy operator access. A stack light beacon shall be located on the top of the enclosure to provide an external indication of a system alarm condition as listed in Section 7 below. Additional alarm and system status information shall be displayed on the PLC text screen. System shall provide the following control and display functions via a Siemens PLC controller:
 - a. Programmable digital timer – Memory backup to retain program memory during power outages
 - b. Pump operating hour counter
 - c. Pump control switch (Auto/Off/Manual) - Key operated, on the display panel of the Smart Filtration Controller
 - d. Power available - Green LED indicator light, on the display panel of the Smart Filtration Controller
 - e. Pump running - Amber LED indicator light, on the display panel of the Smart Filtration Controller
 - f. Alarm - Red LED indicator light for high vacuum, high pressure, high water level in filter bowl, and leak detection alarms - on the display panel of the Smart Filtration Controller
 - g. Alarm reset push button - on the display panel of the Smart Filtration Controller
7. Electrical Enclosure/Controller: All electrical control features shall be contained within a separate UL 508A listed industrial control panel located within the mechanical enclosure. The controller shall monitor the following system alarm conditions:
 - a. Leak in enclosure (system shutdown)
 - b. Primary Filter/Water Separator high vacuum (system shutdown)
 - c. Primary Filter/Water Separator high water level (system shutdown)
 - d. Secondary filter high pressure (system shutdown)
 - e. External system shut down input
8. Pump: Positive displacement, gear, direct coupled, rotary pump. Pump flow rate of 2.5 gallons per minute.
9. Motor: UL Listed, ODP, Thermal overload protection, continuous duty

- C. Performance/Design Criteria: Manufacturer must have a minimum of 10 years experience within industry. System shall be capable to turn complete tank volume over once a week with a required run time of no more than 48 hours for the total volume. Sufficient contaminant and water holding capacity should be ensured, which will vary with climate, tank layout, fuel delivery, refueling intervals, etc.
- D. Operation System shall provide dry contacts for summary alarm and leak detection to interface with building monitoring or alarm system. An external shut down feature shall be provided to disable or control pump operation from a remote point.

PART 3 - EXECUTION

3.1 INSTALLATION AND TESTING OF ABOVE GROUND STORAGE TANKS

- A. EXAMINATION
 1. Examine roughing-in for aboveground fuel-oil storage tanks to verify actual locations.
 2. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. INSTALLATION
 1. General: Tanks to be installed in compliance with all applicable codes, local environmental regulations and safety codes.
 2. Concrete Bases: Anchor aboveground tanks to concrete base according to equipment manufacturer's written instructions and as detailed in Drawings.
 - a. Base Design: To support the tank plus 100 percent of its contents.
 - b. Seismic Design: As necessary for project.
 3. Flood Protection: Tanks located in areas subject to flooding to be protected against flotation.
 4. Grounding: For tanks without cathodic corrosion protection, ground in accordance with local electrical and fire safety codes.
 5. Tank Piping and Accessories: Install all permanent piping using a compatible, non-hardening thread sealant material.
 6. Unused Openings: Properly seal to be liquid and vapor tight.
 7. Labeling: Provide labels in accordance with local code.
 8. Install insulated, steel aboveground tanks according to STI R942.
 9. Fill storage tanks with fuel oil.
- C. FIELD QUALITY CONTROL
 1. Perform the following tests:
 - a. Air Pressure Test:
 - 1) Horizontal Cylindrical Tanks: Minimum of 3 psig and a maximum of 5 psig.
 - b. Leak Detection: Test for leaks along exterior surfaces, welds and fittings.
 2. Tanks will be considered defective if they do not pass the tests.
 3. Prepare test reports.

3.2 INSTALLATION AND TESTING, LEAK DETECTOR SYSTEMS FOR TANKS AND PIPING

- A. Wiring shall conform to NFPA 70.
- B. Locate control monitor panels 4 feet above the floor on inside wall of boiler room, generator room or garage, depending on type of fuel tank served, unless shown otherwise.
- C. Test operation of each probe, and monitoring system with fuel and water. If type of probe utilized is damaged by exposure to fuel, provide temporary probe for testing monitoring system.

3.3 INSTALLATION, TANK FLUID LEVEL INDICATOR AND ALARM SYSTEM

- A. Wiring shall conform to NFPA 70.
- B. Locate level indicator and alarm panel 4 feet above the floor on inside wall of boiler room, generator room or garage, depending on type of fuel tank served, unless shown otherwise.
- C. Locate remote high-level alarm on exterior wall or pole in view of tank fill point, 8 feet above grade.

3.4 INSTALLATION, FUEL OIL QUALITY MAINTENANCE SYSTEMS

- A. Locate systems within easy reach of persons standing on floor, with sufficient elevation to allow gravity flow of water from system to water storage tank sitting on the floor.
- B. Connect to tank suction and return piping systems with isolation valves. Provide compound pressure gauges at suction and discharge piping connections.

3.5 STARTUP AND TESTING

- A. Perform tests as recommended by product manufacturer and listed standards and under actual or simulated operating conditions and prove full compliance with design and specified requirements. Tests of the various items of equipment shall be performed simultaneously with the system of which each item is an integral part.
- B. When any defects are detected, correct defects and repeat test at no additional cost or time to the Owner.
- C. The Commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with Architect and Commissioning Agent. Provide a minimum notice of 10 working days prior to startup and testing.

3.6 DEMONSTRATION AND TRAINING

- A. Provide services of manufacturer's technical representative 4 hours to instruct each Owner personnel responsible in operation and maintenance of the system.
- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Indoor Air Handling Units
 - 2. Split system air conditioning units.
 - 3. Refrigeration piping and fittings.
 - 4. Fans.
 - 5. Relief and intake vents.
 - 6. Louvers.
 - 7. Air inlets and outlets.
 - 8. Terminal Units.
 - 9. Filters.
 - 10. Dampers.
 - 11. Ductwork.
 - 12. Hydronic Piping.
 - 13. Hydronic Pumps.
 - 14. Hydronic Boilers.
 - 15. Air-Cooled Chillers.
 - 16. Valves.
 - 17. Radiant Heater.
 - 18. Expansion Tanks.
 - 19. Air Separators.

1.2 RELATED REQUIREMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 23 00 50, Basic HVAC Materials and Methods.
- C. Section 23 05 93, Testing, Adjusting, and Balancing for HVAC.
- D. Section 23 09 23, Direct Digital Control (DDC) System for HVAC.

1.3 ACTION SUBMITTALS

- A. For additional requirements, refer to Section 23 00 50, Basic HVAC Materials and Methods.
- B. Product Data: Submit manufacturer's technical product data, including rated capacities of selected model clearly indicated, dimensions, weight, corner or mounting point weights, furnished specialties and accessories; and installation and start-up instructions. Product data shall include applicable product listings and standards. Refer to Section 23 00 50, Basic HVAC Material and Methods for additional requirements.
 - 1. Upon approval of submittal, provide manufacturer's installation and operating instructions to the Project inspector for the following:
 - a. Fire dampers, smoke dampers, and combination smoke-fire dampers.
 - b. Type 1 kitchen exhaust field applied grease duct enclosures.
- C. Engineering Data: Submit fan curves and sound power level data for each fan unit. Data shall be at the scheduled capacity. Data shall include the name of the rating agency or independent laboratory.

1.4 INFORMATIONAL SUBMITTALS

- A. For additional requirements, refer to Section 23 00 50, Basic HVAC Materials and Methods.
- B. Roof Curb Data: For roof mounted equipment where combined weight of equipment unit and roof curb or rail exceeds 400 pounds, submit calculations from manufacturer for roof curbs proving compliance with the seismic requirements of the California Building Code, and ASCE 7-10. Manufacturer shall certify that roof curbs are suitable for use indicated on Drawings and in Specifications for the seismic design category indicated in structural Contract Documents. Calculations shall be stamped and signed by a State of California registered structural engineer.
- C. Economizer Fault Detection and Diagnostics (FDD) System Data: For all air-cooled unitary direct-expansion units equipped with an economizer, provide data for third-party supplied California Energy Commission certified FDD controller, documenting compliance with the requirements of California Building Energy Efficiency Standards. Provide evidence of certification.
- D. Record of pre-installation meeting.
- E. Coordinated Layouts: Submit coordinated layouts. For requirements refer to article, Coordinated Layouts, in this Section.

1.5 CLOSEOUT SUBMITTALS

- A. For additional requirements, refer to Section 23 00 50, Basic HVAC Materials and Methods.
- B. Maintenance Data: Submit maintenance data and parts list for each piece of equipment, control, and accessory; including "trouble-shooting guide," in Operation and Maintenance Manual.
- C. Record Drawings: Submit Record Drawings of installed ductwork, duct accessories, and outlets and inlets in accordance with requirements of Division 01.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Belts: One set(s) for each belt-driven unit.
 - 2. Provide one complete set(s) of filters for each filter bank.

1.7 COORDINATED LAYOUT

- A. Coordinated layouts are required to amplify, expand and coordinate the information contained in the Contract Documents.
- B. Provide minimum 1/4 inch equals one foot scaled coordinated layout drawings showing plan and pertinent section or elevation views of piping, ductwork, equipment, accessories, and electrical systems. Drawings shall be reproducible and work of each trade represented shall be fully coordinated with structure, other disciplines, and finished surfaces. Drawings shall be presented on a single size sheet. Coordinated layout drawings shall have title block, key plan, north arrow and sufficient grid lines to provide cross-reference to design Drawings.

1. Provide a stamp or title block on each drawing with locations for signatures from all contractors involved, including but not limited to the General, HVAC, Plumbing, Fire Protection, and Electrical contractors. Include statement for signature that the contractor has reviewed the coordinated layout drawings in detail and has coordinated the work of his trade.
 2. Show on drawings the intended elevation of all ductwork in accordance with the following example:
 - a. B.O.D. = 9'-0"
 OFFSET UP 6"
 B.O.D. = 9'-6"
 3. Highlight, encircle or otherwise indicate deviations from the Contract Documents on the coordinated layouts. Architect will not be responsible for identifying deviations from the original Contract Documents.
- C. Since scale of contract drawings is small and all offsets and fittings are not shown, Contractor shall make allowances in bid for additional coordination time, detailing, fittings, offsets, hangers and the like to achieve a fully coordinated installation. If changes in duct size are required, equivalent area shall be maintained and the aspect ratio shall not be in excess of 2 to 1 unless approved by the engineer. Drawings shall be submitted for review prior to fabrication and installation. Drawings may be submitted in packages representing at least one quarter of the building ductwork.
- D. Check routing on all ductwork before fabricating. Report any discrepancies to Architect. No extra cost will be allowed for failure to conform to above.

1.8 QUALITY ASSURANCE

- A. Design Criteria:
1. All equipment and accessories to be the product of a manufacturer regularly engaged in its manufacture. All gas-fired equipment shall be UL, ETL or CSA listed.
 2. Supply all equipment and accessories in accordance with requirements of applicable national, state and local codes.
 3. All items of a given type shall be products of the same manufacturer.
 4. Scheduled equipment performance is minimum capacity required.
 5. Scheduled electrical capacity shall be considered as maximum available.
 6. Scheduled gas BTU input shall be considered as maximum available.

1.9 FIELD CONDITIONS

- A. Interruption of Existing Services: Do not interrupt services to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary services according to requirements indicated:
1. Notify no fewer than two days in advance of proposed interruption of services.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Insulation products, including insulation, insulation facings, jackets, adhesives, sealants and coatings shall not contain polybrominated diphenyl ethers (PBDEs) in penta, octa, or deca formulations in amounts greater than 0.1 percent (by mass).

2.2 GAS FIRED EQUIPMENT

- A. All gas-fired equipment shall be listed for use as a gas appliance.
- B. All units shall comply with the emissions requirements of the Air Quality Management District (AQMD) in which they are to be installed.

2.3 INDOOR AIR HANDLING UNITS

- A. Manufacturer shall be a company specializing in the design and manufacture of commercial / industrial custom HVAC equipment. Manufacturer is required to have a minimum of 10 years experience in the production of custom HVAC equipment and can provide contact list information for local jobsites with minimum of 5 years of operation.
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following, or equal:
 - 1. Carrier Corporation; a unit of United Technologies Corp.
 - 2. Daikin Applied.
 - 3. Trane.
 - 4. YORK; a Johnson Controls company.
- C. General: Provide factory-fabricated air handling units with capacity as indicated on the schedule. Units shall have overall dimensions as indicated and fit into the space available with adequate clearance for service as determined by the Engineer. Units shall be completely assembled. Multiple sectioned units shall be shipped as a single factory assembled piece (except where shipping limitations prevent) de-mounted into modular sections in the field by the contractor. Units shall be furnished with sufficient gasket and bolts for reassembly in the field by the contractor. Unit manufacturer shall provide certified ratings conforming to the latest edition of AMCA 210, 310, 500 and ARI 410. All electrical components and assemblies shall comply with NEMA standards. Unit internal insulation must have a flame spread rating not over 25 and smoke developed rating no higher than 50 complying with NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems." Units shall comply with NFPA 70, "National Electrical Code," as applicable for installation and electrical connections of ancillary electrical components of air handling units. Tags and decals to aid in service or indicate caution areas shall be provided. Electrical wiring diagrams shall be attached to the control panel access doors. Operation and maintenance manuals shall be furnished with each unit. Units shall be UL or ETL listed.
- D. Unit Base - Unit perimeter base shall be completely welded and fabricated using heavy gauge structural steel tubing. (Note: bolted bases are not acceptable) C-Channel cross supports shall be welded to perimeter base steel tubing and located on maximum 24" centers to provide support for internal components. Base rails shall include lifting lugs welded to perimeter base at the corner of the unit or each section if de-mounted. Entire base frame is to be painted with a phenolic coating for long term corrosion resistance. Internal walk-on floor shall be 12 gauge aluminum tread plate. The outer sub-floor of the unit shall be made from 20 gauge galvanized steel. The 4" double wall floor shall be insulated. Floor seams shall be gasketed for thermal break and sealed for airtight / watertight construction. Where access is provided to the unit interior, floor openings shall be covered with walk on steel safety grating. Single wall floors with glued and pinned insulation and no sub floor are not acceptable. Base frame shall be attached to the unit at the factory. The base and unit frame shall be painted with a lacquer resisting phenolic corrosion inhibitive primer.
- E. Rigging Provision – Multiple Piece Units: Units shipped in multiple sections shall be engineered for field assembly. The base frame shall have integral lifting lugs. The lifting lugs shall be fabricated from structural steel with an appropriate rigging hole. Lifting lugs shall be

located at the corner of each section (and along the sides if required) and sized to allow rigging and handling of the unit. Demount sealing gasket shall be required and provided. Internal lifting eyes shall be provided so that mating sections can be set together in their proper location by the crane without dragging or pushing them together. The mating upper frame of each section shall also be fabricated with a mating perimeter tube. Mating sections shall have bolt brackets attached with oversized clearance holes for alignment and assembly. The mating perimeter tube shall be continuously gasketed. High-quality, weather-resistant closed cell type demount gasket shall be supplied with the unit. Assembly lugs, fabricated from structural steel with appropriate assembly clearance holes, shall be electrically welded to the base frame. All gasket and necessary assembly hardware shall ship loose with unit. Junction boxes with a factory supplied numbered terminal strip shall be supplied at each shipping split for reconnection of control wiring.

- F. Unit Casing – The construction of the air handling unit shall consist of double-wall construction with internal wall insulation, solid smooth interior with wipe-down and cleanable interior surfaces. Manufacturer shall provide calculations certifying the internal insulation meets or exceeds a 0.08 U-Factor (BTU/hr/ft²/F) with 3” thickness. Casing material shall be aluminum or galvanized steel. All casing panels shall be completely removable from the unit exterior without affecting the unit’s structural integrity. Provide necessary support to limit casing deflection to L/240 of overall unit length. If panels cannot meet this deflection, additional internal reinforcing is required. All panel seams shall be caulked and sealed for an airtight unit. Leakage rates shall be less than 1.5% at design static pressure.
- G. The exterior panel finish shall be: Painted with a polyester resin coating designed for long term corrosion resistance meeting or exceeding (ASTM B-117) Salt Spray Resistance at 95 degrees F. 1,000 hrs. and (ASTM D-2247) Humidity Resistance at 95 degrees F. 1,000 hrs.
- H. Double Wall Liner - Each unit shall have double wall construction with 20 gauge solid galvanized liner or 22 gauge perforated galvanized liner as indicated. The double wall interior panel shall be 3” thick and removable from the outside if the unit without affecting the structural integrity of the unit.
- I. Access Doors - The unit shall be equipped with a solid double wall insulated, hinged access doors as shown on the plans. The doorframe shall be extruded aluminum with a full perimeter closed-cell double neoprene or interlocking EPDM gasket . The door hinge assembly shall be die cast zinc with stainless steel pivot mechanism, completely adjustable. There shall be a minimum of two heavy duty handles per door. Provide ETL, UL 1995, and CAL-OSHA approved tool operated safety latch on all fan section access doors.
- J. Fan Assemblies: Fan assemblies shall be designed for heavy duty industrial applications. Fan framing assemblies shall be fabricated from structural steel. Formed members are not acceptable. This structural steel shall be electrically welded together to form a rigid integral base. Fan assemblies shall be independently isolated with vibration isolators. Vibration isolators shall be mounted to a structural angle on the fan base assembly.
 - 1. Motors shall be IEEE inverter duty, premium efficiency TEFC T-frame motors selected at the specified operating voltage, RPM, and efficiency as specified or scheduled elsewhere. Each motor shall be provided with shaft grounding.
 - 2. Sheaves and belts: All sheaves shall be selected with a 1.5 service factor. Sheaves shall be machined from a close grain cast iron and statically balanced by the manufacturer. Drive belts shall be a V type. Variable pitched sheaves shall be provided on motors from 1 to 15 horsepower. Fixed pitch sheaves shall be provided on motors larger than 15 horsepower. Where fixed sheaves are provided one sheave exchange shall be provided from the factory. Belts shall be oil and heat resistant. Removable OSHA qualified belt guards shall be provided.

3. Variable frequency drives: Each variable air volume supply and return fan shall be provided with separate variable frequency drives. Drives shall be factory mounted with adequate ventilation provided.
- K. Each section shall be equipped with a vapor- proof 100 watt service light with a guard.
- L. Provide a 120 volt GFI duplex convenience outlet on the exterior of the unit.
- M. Heat Transfer Coils – Water Coil:
1. All coil assemblies shall be leak tested under water at 315 PSIG and certified under ARI Standard 410.
 2. Cooling coils shall be mounted on stainless steel support rack to permit coils to slide out individually from the unit. Provide intermediate drain pans on all stacked cooling coils. The intermediate pan shall drain to the main drain pan through a copper downspout. Water coils shall be constructed of seamless copper tubing mechanically expanded into fin collars. All fins shall be continuous within the coil casing to eliminate carryover inherent with a split fin design. Fins are die formed Plate type.
 3. Headers are to be seamless copper with die formed tube holes.
 4. Connections shall be male pipe thread (MPT) Schedule 40 Red Brass with 1/8" vent and drain provided for complete coil drainage. All coil connections shall be extended to the exterior of the unit casing by the manufacturer. Coils shall be suitable for 250 PSIG working pressure. Intermediate tube supports shall be supplied on coils over 44" fin length with an additional support every 42" multiple thereafter.
 5. Water coils shall have the following construction: 5/8" o.d. x .035" wall copper tube with 0.008" aluminum fins, 16 gauge 304 stainless steel casing
- N. Condensate / Drain Pans: IAQ style drain pans shall be provided under all cooling coils. The drain pan shall be fabricated from 14 gauge 304 stainless steel. All pans are to be triple pitched for complete drainage with no standing water in the unit. They shall be insulated minimum 3-inch "Double Bottom" construction with welded corners. Provide stainless steel, 1-1/4" MPT drain connection extended to the exterior of the unit base rail. All drain connections shall be piped and trapped separately for proper drainage.
- O. Filters
1. Pre filters shall be 2" thick, MERV 8. Filter media shall be 100% synthetic. The filters shall be listed as Class II under UL Standard 900. Filters shall be tested per ASHRAE Standard 52-76. Camfill FARR model 30/30 or approved equal.
 2. High Efficiency filters shall be 12" deep, MERV13, supported media box type. Class II. Camfill FARR Riga-Flo or approved equal.
 3. Filters are mounted back to back for front loading. Type 8, 316 stainless steel filter frames
 4. Provide and install a magnehelic filter gauge with a 4³/₄" OD white static pressure dial with black figures and zero pointer adjustment. Dwyer Series 2002 Air filter gauge. Set at 1.5" change out.
- P. OA, RA & EA Dampers: Ruskin CD-50, or approved equal. Provide Class 1 rated, ultra low leak dampers as shown on the unit drawings. Low leakage dampers shall have extruded aluminum airfoil blades. Flat or formed metal blades are not acceptable. The damper blade shall incorporate santoprene rubber edge seals and zinc plated tubular steel shaft for a non-slip operation. Shaft bearings holes shall be N.C. machine punched and fitted with one inch O.D. heavy duty nylon bearings to eliminate friction and any metal to metal contact. Damper jamb seals shall be UV rated, nylon glass reinforced or stainless steel spring arcs designed for a minimum air leakage and smooth operation. Damper linkage shall be concealed within a 16 gauge galvanized steel frame.
- Q. Louvers:

1. Exhaust Air applications - Provide extruded aluminum stationary louvers, drainable type with built in downspouts and bird screen. Blades shall be housed inside a 16 ga. galvanized steel frame mounted to the unit exterior. Louver finish to match exterior unit finish.
 2. Outside Air applications - extruded aluminum louvers shall be used at O/A location. Louvers shall be stationary, drainable type with built in downspouts and furnished with bird screen. Blades shall be 6" deep, vertical and housed inside an aluminum frame mounted to the unit exterior. Louver finish to match exterior unit finish.
- R. Airflow Measuring Stations: Air monitoring stations shall be tested to AMCA Standard 611-95 and be qualified to bear the AMCA Ratings Seal for Airflow Measurement performance.
- S. Outside Air Measurement:
1. Option 1: Ruskin AMS50 (or equal) combination control damper and flow measurement station in one assembly.
 2. Option 2: Ebtron GTC-116Pc (or equal) airflow measurement station with separate control damper. Transducer shall provide a 4-20 ma output signal.
- T. Supply and Return Airflow measurement:
1. Each fan system shall be equipped with a complete flow measuring system. The flow measuring station shall not obstruct the inlet of the fan and has no effect on fan performance (flow or static) or sound power levels. A transducer shall provide a 4-20 milliamp output control signal for use in the BAS.
 2. Each fan requires an airflow measuring station.
- U. Standard Factory Tests: The fans shall be factory run tested to ensure structural integrity and proper RPM. All electrical circuits shall be tested to ensure correct operation before shipment of unit. Units shall pass quality control and be thoroughly cleaned prior to shipment.
- V. Factory Leak Testing: Cabinet leakage is not to exceed 1.5% of specified airflow on the operating side of the unit. A written test report shall be prepared by the manufacturer and issued to the Owner's representative.
- W. Factory Sound Testing: The equipment manufacturer shall furnish calculations showing the estimated sound power levels at the supply and, return connections, as well as unit casing radiation for each air conditioning unit. Calculations shall be based on fan sound power levels which were determined in accordance with AMCA Standard 300 and 301. Sound power levels shall be determined for each octave band. A written test report shall be prepared by the manufacturer and issued to the Owner's representative.

2.4 SPLIT SYSTEM AC UNIT

- A. General: Furnish and install split system air conditioner, with R410A refrigerant, and complete with automatic controls. Equipment shall be shipped factory assembled, wired, tested, and ready for field connections.
- B. Quality Assurance:
1. Unit shall be ETL or UL listed and labeled.
 2. Unit shall be manufactured in a facility registered to ISO 9001:2000.
 3. Unit shall be rated in accordance with ARI standard 210.
- C. Delivery, Storage and Handling: Follow manufacturer's recommendations.

- D. Cooling System: The total certified cooling capacity shall not be less than scheduled. The compressor power input shall not exceed that of the unit specified.
- E. Indoor Section: Wall mounted, ceiling surface mounted, or ceiling recessed mounted, as indicated on Drawings.
 - 1. Cabinet:
 - a. Wall mounted: Molded white high strength plastic.
 - 1) Provide wall mounted unit with factory mounting plate.
 - b. Ceiling surface mounted: Molded white high strength plastic with provision for outside air duct connection.
 - c. Ceiling recessed mounted: galvanized steel with provision for outside air duct connection.
 - 2. Fans: Double inlet, forward curved, statically and dynamically balanced.
 - 3. Fan Motor: Direct drive, permanently lubricated, with two or 4 speed operation for unit size scheduled on Drawings.
 - a. For single-phase fan motors sized larger than 1/12 hp and smaller than 1 hp, refer to Article, Electric Motors, in Section 23 00 50, Basic HVAC Materials and Methods.
 - 4. Air Outlet: With motorized horizontal and vertical vanes.
 - a. Wall and ceiling surface mounted units: Horizontal vane shall close air outlet upon unit shut-down.
 - 5. Evaporator Coil: Aluminum fins mechanically bonded to copper tubes. Coils shall be pressure leak tested.
 - 6. Insulation: Interior surfaces exposed to the airstream shall be fully insulated.
- F. Outdoor Section:
 - 1. Casing: Galvanized steel plate, powder coated with acrylic or polyester.
 - 2. Condenser Fan Grille: ABS plastic.
 - 3. Fan and fan motor: Direct drive, totally enclosed, propeller type, permanently lubricated, horizontal discharge.
 - 4. Compressor: Variable speed rotary type, with crankcase heater and accumulator. Compressor shall be capable of operating at 0 degrees F. Compressor mounted on vibration isolator pads.
 - 5. Coil: Aluminum fins mechanically bonded to copper tubes. Coils shall be pressure leak tested. Provide coil with integral metal guard.
- G. Controls: Hard wired, microprocessor based, wall mounted controller with LCD display shall provide the following functions, as a minimum:
 - 1. 7-day programmable timer.
 - 2. Test and check functions.
 - 3. Diagnostic functions.
 - 4. Vane position control.
 - 5. Fan speed adjustment.
 - 6. Temperature adjustment.
 - 7. Automatic restart.
 - 8. Mode selection, including cool/dry/fan.
 - a. Provide lockable enclosure for wall mounted controller.
- H. Safeties: Shall include the following, as a minimum:
 - 1. Five minute compressor anti-recycle timer.
 - 2. High pressure protection.
 - 3. Current and temperature sensing motor overload protection.
- I. Filters: Provide 1 inch thick fiberglass throwaway filters with cardboard holding frames for indoor unit. Provide sufficient filters for four complete changes for each unit.

- J. Service Access: All components, wiring, and inspection areas shall be completely accessible through removable panels.
- K. Refrigerant Piping:
 - 1. Provide factory pre-charged and sealed line set piping, length to suit the location of equipment. Tubing sizes shall be in accordance with manufacturers written instructions.
 - 2. Provide refrigeration piping in accordance with Article, Refrigerant Piping, in this Section.
- L. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - 1. Mitsubishi Electric Corporation.
 - 2. Carrier Corporation.
 - 3. Sanyo Electric Co., Ltd.
- M. Owner Training: Manufacturer shall provide one on-site 2-hour training session for Owners' maintenance personnel.

2.5 REFRIGERATION PIPE AND FITTINGS

- A. Refrigeration gas and liquid piping shall be type ACR hard drawn copper tubing, cleaned and capped in accordance with ASTM B280, with wrought copper fittings. All joints shall be brazed with Sil-fos under nitrogen purge. Relief valve discharge piping shall be full size of relief discharge port.
 - 1. Manufactured, pre-charged and pre-insulated refrigerant line-set refrigerant piping may be utilized at Contractor's discretion.
 - a. VRF Systems: Use of manufactured, pre-charged and pre-insulated refrigerant line-set refrigerant piping between outdoor condensing units and indoor heat recovery controllers, or distribution headers and tees is not allowed. When system manufacturer's installation instructions allow use of refrigerant line-set piping between indoor heat recovery controllers, or distribution headers and tees, and air terminal devices, follow instructions for allowable pipe size range and support to avoid forming traps in the piping.
- B. Refrigeration Piping Specialties: Furnish and install Superior, Sporlan, Alco, Henry, or equal, stop valves, solenoid valves, adjustable thermal expansion valves, sight glass, flexible connection, charging valve, and drier with valve bypass in the liquid lines and Superior DFN shell and cartridge suction line filter sized 2-1/2 times tonnage.
 - 1. Install only those refrigeration piping specialties recommended by manufacturer of specific installed equipment.

2.6 FANS

- A. All fans shall be Air Moving and Control Association Inc. (AMCA) labeled.
- B. Provide self-aligning, enclosed ball bearings, accessible for lubrication unless specified otherwise.
- C. Provide variable speed switch for all direct drive fans.
- D. Roof Mounted:
 - 1. Direct or V-belt Drive: Provide one-piece heavy-duty ventilator housings, one piece heavy gauge spun aluminum construction, with weatherproof assembly and integral weather shield. Mount ventilators on curbs furnished by the fan manufacturer. Install with fan assembly level.

2. Fan wheels shall be centrifugal design, statically and dynamically balanced. Tip speed, rpm and motor horsepower shall not exceed listing in manufacturer's catalog for unit specified.
 3. Fans shall have integral factory formed base and one piece spinning without welding. Housings shall be provided with wiring channel and are to be of the direct discharge design. Motor and fan assembly shall be on vibration isolating mounts. Fans shall have capacity, speeds and motor sizes as shown.
 4. Provide the following accessories:
 - a. Gravity backdraft dampers.
 - b. Aluminum bird screen with a minimum of 85 percent free area.
 - c. Adjustable motor pulley.
 - d. Laboratory fume hood exhaust fans shall be Keysite coated.
 - e. Provide grease collection tray for kitchen exhaust fans.
 - f. Provide ventilated roof curb for kitchen exhaust fans where exhaust duct is mounted within rated shaft.
 - g. Provide hinge kit for kitchen hood exhaust fans.
- E. In-Line Centrifugal Fans:
1. Centrifugal fan with airfoil blades, aluminum or steel housing, externally mounted belt-drive motor, external lube tubes, integral support brackets.
 2. Provide sloped roof or flat roof type roof cap, or wall cap to suit the location indicated on the Drawings.
- F. Ceiling Mounted Fans:
1. Acoustic lined cabinet, built-in back draft damper, vibration isolated fan and motor, variable speed switch.
 2. Provide sloped roof or flat roof type roof cap, or wall cap to suit the location indicated on the Drawings.
- G. Fan Drives:
1. Drive Design: The design horsepower rating of each drive shall be at least 1.5 times, single belt drives 2 times, the nameplate rating of the motor with proper allowances for sheave diameters, speed ratio, arcs of contact and belt length.
 2. Provide variable speed drives, Dayco, Browning, Woods, or equal. Allow for replacement of fan and motor drives and belts as required to suit the balance requirements of the project.
 3. Select variable speed drives to allow an increase or decrease of minimum of ten percent of design fan speed.
- H. Motors:
1. Motors of 25 HP and less shall have adjustable pitch sheaves; sheaves on motors above 25 HP may be non-adjustable. Change, at no extra cost to Owner, the non-adjustable sheaves to obtain desired air quantities.
 2. For single-phase fan motors sized larger than 1/12 hp and smaller than 1 hp, refer to Article, Electric Motors, in Section 23 00 50, Basic HVAC Materials and Methods.
- I. Sheaves: Sheaves shall be cast or fabricated, bored to size or bushed with fully split tapered bushings to fit properly on the shafts. All sheaves shall be secured with keys and set screws.
- J. Belts:
1. All belts shall be furnished in matched sets.
 2. Belts shall be within 1 degree 30 minutes of true alignment in all cases.

- K. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - 1. Greenheck Fan Corporation.
 - 2. Loren Cook Company.
 - 3. PennBarry.
 - 4. American Coolair Corporation.
- L. Owner Training: Manufacturer shall provide one on-site 1-hour training session for Owners' maintenance personnel.

2.7 LOUVERS

- A. Louvers shall be minimum 16 gauge steel with Bonderite and Epon gray primer and 1/2 inch square mesh, 16 gauge galvanized steel screen on the inside. Louvers shall be Airolite #609, Arrow United Industries, or equal, with 4 inch louver depth.

2.8 AIR INLETS AND OUTLETS

- A. Except as otherwise indicated, provide manufacturer's standard inlets and outlets where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.
- B. Ceiling, wall or floor Compatibility: Provide inlets and outlets with border styles that are compatible with adjacent ceiling, wall or floor systems, and that are specifically manufactured to fit into ceiling, wall or floor module with accurate fit and adequate support. Refer to general construction drawings and specifications for types of ceiling systems that will contain each type of air outlet and inlet.
- C. Refer to Schedule on Mechanical Drawings for details of inlets and outlets to be used.

2.9 AIR TERMINAL UNITS

- A. Shutoff, Single-Duct Air Terminal Units:
 - 1. Configuration: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.
 - 2. Casing: 0.034-inch-thick galvanized steel, single wall .
 - a. Casing liner: Fibrous-glass duct liner, complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
 - 1) Minimum Thickness: 1/2 inch.
 - 2) Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
 - 3) Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
 - 4) Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
 - a) Adhesive VOC Content: 80 g/L or less.
 - b) Adhesive shall comply with testing and product requirements of South Coast Air Quality Management District, Rule 1168.
 - c)
 - 3. Inlets and Outlets: Air inlet shall be round or rectangular stub connection or S-slip and drive connections for duct attachment. Air outlet shall be S-slip and drive connections, size matching inlet size.

4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.
5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
6. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
 - a. Maximum Damper Leakage: AHRI 880 rated, 2 percent of nominal airflow at 3-inch wg 6-inch inlet static pressure.
7. Hydronic Heating Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve.
8. Controls:
 - a. Air terminal units shall be furnished with damper and multipoint velocity sensor. Damper actuator, pressure-independent, variable-air-volume (VAV) or constant-air-volume (CAV) controller with electronic airflow transducer, and room sensor are specified in Section 23 09 23 "Direct Digital Control (DDC) System for HVAC.
 - b. Control devices shall be compatible with temperature controls system specified in Section 23 09 23 "Direct Digital Control (DDC) System for HVAC."
 - 1) Electronic Damper Actuator: 24 V, powered open, spring .
 - 2) Terminal Unit Controller: Pressure-independent, variable-air-volume (VAV) or constant-air-volume (CAV) controller with electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes, and having the following features:
 - a) Occupied and unoccupied operating mode.
 - b) Remote reset of airflow or temperature set points.
 - c) Adjusting and monitoring with portable terminal.
 - d) Communication with temperature-control system.
 - 3) Room Sensor: Wall mounted, with the following features:
 - a) Digital display of sensed temperature.
 - b) Local temperature setpoint adjustment. Capable of manual override through control system operator.
 - c) Local override to turn HVAC on. Capable of manual override through control system operator.
 - d) Access for connection of portable operator terminal.
9. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
 - a. Price Limited.
 - b. Titus.
 - c. Johnson Controls, Inc.

2.10 AIR FILTERS

- A. Provide MERV 8 disposable pleated media type. Refer to specific equipment Articles for filter depth and for exceptions to this specification. Filters shall conform to the following:
 1. Standards:
 - a. ASHRAE Standard 52.2-2007.
 - b. Underwriters Laboratories: U.L. 900, Class 2.
 2. Construction:
 - a. Media: Synthetic or cotton-synthetic blend with radial pleats.
 - b. Media Frame: High wet-strength beverage board.
 - c. Media Support: Welded wire or expanded metal grid bonded to air leaving side of the media.
 3. Performance: 2" deep filter shall have a maximum initial air resistance of 0.31 inches w.g.

- B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - 1. Camfil Farr, Inc., model 30/30.
 - 2. Flanders Corporation, model 40 LPD.

- C. Temporary (Construction Period) Filters:
 - 1. Install new temporary filters in all units that have filter systems installed. Temporary filters shall match the permanent filters that are specified for the units. Replace filters as needed, in accordance with manufacturer's directions, in order to provide protection for the unit prior to occupancy by the Owner.
 - 2. If air handling units are operated during construction of the project, install temporary filters directly over each return air inlet. Filters shall match the permanent filters that are specified for the units. Select size of filter to completely cover the frame of the return air inlet, and tape filters firmly in place to eliminate any construction debris from entering the duct system or unit. Remove the temporary filters upon completion of the work, and repair all damaged paintwork.

- D. Spare Filters:
 - 1. Furnish two new, complete sets of filter cartridges for each filter bank on completion and acceptance of the work. Install one set of filters in units (prior to final air balance). Provide units designed to accommodate washable, permanent filters with one washable, permanent filter.

2.11 DAMPERS

- A. Backdraft Dampers: Ruskin CBD2, counterbalanced, Nailer Industries, or equal.

- B. Manual Air and Balance Dampers: Provide dampers of single blade type or multi-blade type constructed in accordance with SMACNA, "HVAC Duct Construction Standards," except as noted herein.
 - 1. Rectangular Ductwork:
 - a. Single damper blades may be used in ducts up to 10 inches in height. Dampers shall be 16 gauge minimum. Provide self-locking regulators, equal to Ventlok 641. Provide end bearings equal to Ventlok 607 at each damper. Provide continuous solid 3/8 inch square shafts.
 - b. Multiple blade dampers shall be equal to Ruskin CD35 Standard Control Damper. Maximum width for multiple damper blades for use in rectangular duct shall not exceed 6 inches.
 - c. Where duct velocity may be expected to exceed 1500 fpm, provide Ruskin CD-50, or equal, low leakage dampers with airfoil blades.
 - 2. Round Ductwork:
 - a. Single damper blades may be used in ducts up to 12 inches in diameter. Provide multiple blade opposed blade dampers, with connected linkage, for ductwork larger than 12 inches in diameter.
 - b. Damper blades for round ductwork shall be 20 gauge steel for ducts up to 12 inches diameter and 16 gauge steel for dampers larger than 12 inches diameter. Provide self-locking regulators, equal to Ventlok 641, Durodyne, or equal for operation of dampers. Provide end bearings equal to Ventlok 607 and provide continuous solid 3/8 inch square shafts.
 - 3. Where ductwork is externally insulated, provide self-locking regulators equal to Ventlok 644, Durodyne, or equal for rectangular ductwork, and Ventlok 637, Durodyne, or equal for round ducts.

- C. Fire Dampers and Combination Fire/Smoke Dampers:

1. Fire dampers and combination fire/smoke dampers shall be listed and approved by the California State Fire Marshal. Installation shall conform to the manufacturer's UL approved installation instructions.
 - a. Fire dampers shall be UL 555 classified and labeled as dynamic fire dampers approved for wall and floor installation. They shall ship from the manufacturer as an assembly with a minimum 20-gauge factory installed sleeve. Sleeve length shall suit the requirements of the wall construction. Each dynamic fire damper/sleeve assembly shall ship complete with factory "roll formed" one-piece angles with pre-punched holes for easy installation. Dynamic fire dampers for vertical installation must consist of a single section on sizes up to 33" x 36" and a single section on sizes up to 24" x 24" for horizontal installation. 1-1/2 hour dynamic fire dampers shall be Ruskin DIBD20, Pottorff, or equal. 3 hour dynamic fire dampers shall be Ruskin DIBD230, Pottorff, or equal.
 - b. Fire dampers for high pressure/velocity systems where velocities exceed 2000 fpm and/or 4" w.g. pressure fire damper shall be Ruskin FD60, Pottorff, or equal
 - c. Fire dampers for ceiling installation shall be UL 555C classified and labeled as ceiling dampers. They shall be provided with a thermal insulating blanket to fit the inlet or outlet condition if required by the application. Ceiling dampers shall be Ruskin CFD 2, 3, 4 or 5. Ceiling dampers for ceilings constructed of wood shall have UL tested in design L501 and shall be Ruskin CFD7, Pottorff, or equal.
 - d. Combination fire/smoke dampers. Dampers shall be UL classified and labeled as Leakage Class I Smoke Dampers in accordance with the latest version of UL 555S. Dampers shall be warranted to be free from defects in material and workmanship for a period of 5 years after date of shipment. Damper/actuator assembly shall be tested to full open and full close at minimum 2000 fpm 250° F heated air and 4" w.g. with airflow in both directions. (Specified select: 250° / 350°, 2000 fpm/3000 fpm). Each damper shall be equipped with "controlled closure" quick detect heat actuated release device to prevent duct and HVAC component damage resulting from instantaneous damper closure. Release device shall be EFL type and shall allow reset from outside the sleeve after moderate temperature exposure. (Replacement type fusible links not acceptable.)
 - e. Two position combination fire smoke dampers shall be equipped with one or more factory installed, direct coupled, 120 volt, single phase, electric actuator for energize open – fail close operation. Dampers with multiple actuators shall be factory wired with single point connection at the EFL heat release device for connection to poser. Damper actuator shall include minimum one-year energized hold open (no cycles) and spring return (fail) close reliability. Damper/actuator shall include minimum 20,000 full open-full close cycle performances.
 - f. Modulating combination fire smoke dampers shall be equipped with one or more factory installed contact for modulating signal connection. Damper/actuator shall include minimum 100,000 full open-full close cycle performances with spring return (fail) close on loss of power.
 - g. Round combination fire smoke dampers up to 24" diameter shall be true round type with minimum 20 gauge galvanized steel designed for lowest pressure drop and noise performance. Bearings shall be stainless steel sleeve turning in an extruded hole in the frame. Blade seals shall be silicone edge designed to withstand 450° F and galvanized steel mechanically locked in to the blade edge (adhesive type seals are not acceptable). Each damper shall be equipped with a factory-installed sleeve of 17 inches minimum length and factory "roll formed" one-piece angles with pre-punched holes. Dampers shall be Ruskin FSDR25, Pottorff, or equal.

- h. Round (larger than 24" diameter) or rectangular combination fire smoke dampers shall include roll-formed structural hat channel frame, reinforced at the corners, formed from a single piece of minimum 16 gauge equivalent thickness formed from single piece galvanized steel. Bearings shall be stainless steel turning in an extruded hole in the frame. Blade edge seals shall be silicone rubber designed to withstand 450° F and galvanized steel mechanically locked in to the blade edge (adhesive type seals are not acceptable). Each damper shall be equipped with a factory-installed sleeve of 17" minimum length and factory "roll formed" one-piece angles with pre-punched holes for easy installation. Dampers shall be Ruskin FSD60, Pottorff, or equal.
- i. 3-hour rated combination fire smoke dampers shall be Ruskin model FSD60-3, Pottorff, or equal.
- j. All FSD60 type dampers shall be AMCA licensed and shall bear the AMCA Seal for Air Performance. AMCA certified testing shall verify pressure drop does not exceed .03" w.g. at a face velocity of 1,000 fpm on a 24" x 24" damper.
- k. Wall type fire/smoke damper:
 - 1) Combination fire/smoke dampers for use in the wall of exit corridors shall be classified and labeled as Leakage Class II Smoke Dampers in accordance with the latest version of UL 555S. Dampers shall meet the requirements for combination fire/smoke dampers in paragraph 3 above except AMCA certified testing shall verify pressure drop does not exceed .07" w.g. at a face velocity of 1,000 fpm on a 24" x 24" damper and blades shall be single skin galvanized steel 10 gauge minimum with 3 longitudinal grooves for reinforcement. Dampers shall be Ruskin FSD36, Pottorff, or equal.
 - 2) Front access combination fire/smoke dampers shall meet all the requirements for combination fire/smoke dampers in paragraph 3 above except pressure drop requirement. In addition the dampers shall be constructed so that actuators and all accessories are accessible from the grille side. Actuators and accessories shall be housed within an integral cabinet on the side of the damper frame and shall not be installed in the air stream in front of the damper. The damper sleeve shall be minimum 14" and flanged to accept a steel framed grille. The sleeve shall be covered with fire resistant material. Dampers shall be Ruskin FSD60FA, Pottorff, or equal.
- l. Ceiling type fire/smoke damper for tunnel type corridor construction: Combination fire/smoke dampers for use in the corridor ceiling of tunnel type corridor construction shall be UL classified and labeled as Corridor Damper. Dampers shall meet the requirements of paragraph 4a above except pressure drop testing does not require AMCA certification. Dampers shall be Ruskin FSD36C, Pottorff, or equal.
- m. Fusible links shall have temperature rating approximately 50° F above normal maximum operating temperature of the heat producing appliance.
 - 1) If project requires re-openable fire/smoke dampers, provide Ruskin 165 ° F / 350° F TS150, NCA or equal. The TS150 firestat replaces the EFL and allows the damper to be re-opened from remote location up to 350 ° F. TS150 shall include full open and full closed damper position contacts for interface with remote position indication panel.
 - 2) Each fire/smoke damper shall be equipped with "controlled closure" quick detect heat actuated release device to prevent duct and HVAC component damage. Release device shall allow easy reset after moderate temperature rise outside the sleeve. Heat release device shall be the Ruskin EFL, NCA or equal.

- 3) Unless the system is using a validation control system, each fire/smoke damper shall be equipped with a control panel including blade position indicator lights and a key operated switch. The panel cover shall be oversized for flush mount into the wall or ceiling and shall have a brushed look. Control panel shall be Ruskin MCP2, Pottorff, or equal.
2. All actuators used for smoke dampers or combination fire/smoke dampers shall have a cycle time requirement of not more than every twelve months and shall be rated for continuous "On" duty and shall be provided with internal spring return. Actuators shall be equipped with pilot light, remote key test switch, end switch and circuitry to activate pilot light on remote key (test) switch located in corridor ceiling adjacent to damper. Electric motors shall be Invensys MA-250, MA-253, Honeywell H2000, or equal.
- D. Where required to suit the size of damper required, provide manufacturers standard UL Classified mullions, arranged to support multiple dampers. Assembly shall be of minimum 16 gauge galvanized steel, complete with all accessory caps and framing members required for installation.

2.12 DUCTWORK

- A. Construct and install all sheet metal ductwork in accordance with the California Mechanical Code for 2 inches static pressure for supply air, and 2 inches minimum for return and exhaust air unless otherwise noted on Drawings.
- B. Construct and install sheet metal ductwork in accordance with the California Mechanical Code for 4 inches static pressure upstream of terminal units and 2 inches minimum downstream of terminal units for supply air, and 2 inches minimum for return and exhaust air unless otherwise noted on Drawings.
 1. Where not in conflict with the California Mechanical Code, construct and install all sheet metal ductwork in accordance with SMACNA HVAC Duct Construction Standards (Metal and Flexible). Where applicable for HVAC work, construct and install sheet metal work in accordance with SMACNA Architectural Sheet Metal Manual.
 2. Provide variations in duct size, and additional duct fittings as required to clear obstructions and maintain clearances as approved by the Architect at no extra cost to the Owner.
 3. Gauges, joints and bracing shall be in accordance with the California Mechanical Code.
 4. Provide beading or cross breaking for all ductwork inside building. Provide cross breaking for ductwork exposed to weather.
 5. At the contractor's option, ductwork may be fabricated using the Ductmate, Nexus, Quickduct, Transverse Duct Connection (TDC), Pyramid-Loc duct connection systems, or equal. Fabricate in strict conformance with manufacturer's written installation instructions and in accordance with California Mechanical Code.
 - a. Seal flanged ends with pressure sensitive high density, closed cell neoprene or polyethylene tape gasket, Thermo 440, or equal.
 - b. Provide metal clips for duct connections, except at breakaway connections for fire dampers and fire smoke dampers. Provide corner clips at each corner of duct, through bolted, at all locations except at breakaway connections for fire dampers and fire smoke dampers. Where used on locations exposed to weather, provide continuous metal clip at top and sides of duct, with 1 inch overhang for top side.
- C. Design and installation standards:
 1. SMACNA Compliance: Comply with applicable portions of Sheet Metal and Air Conditioning Contractor's National Association (SMACNA) for all work in this section.
 2. NFPA Compliance: Comply with ANSI/NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems," and ANSI/NFPA 90B, "Standard for the Installation of Warm Air Heating and Air Conditioning Systems."

- 3. California Mechanical Code.
- D. Fabricate all ductwork with sheet metal. Fiberglass ductwork will not be accepted for use on this project.
- E. Duct sizes indicated are external sizes.
- F. Galvanized Sheet Steel: Lock-forming quality, ASTM A924 and ASTM A653, Coating Designation G 90. Provide mill phosphatized finish for exposed surfaces of ducts exposed to view.
 - 1. Provide mill certification for galvanized material at request of the Project Inspector.
- G. Duct Sealants:
 - 1. Sealant shall have a VOC content of 250 g/L or less.
 - 2. Sealant shall comply with testing and product requirements of South Coast Air Quality Management District, Rule 1168.
 - 3. Provide one part, non-sag, synthetic latex sealant, formulated with a minimum of 68 percent solids. Sealant shall comply with ASTM E84, Surface Burning Characteristics.
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - 1) Design Polymerics, model DP1010.
 - 2) Polymer Adhesive Sealant Systems Inc, model Airseal #11.
 - 3) McGill Airseal, LLC.
- H. Provide sheet metal angle frame at all duct penetrations to wall, floor, roof, or ceiling.
- I. Duct Support Materials: Except as otherwise indicated, provide hot-dipped galvanized steel fasteners, anchors, straps, trim, and angles for support of ductwork.
- J. Rectangular Duct Fabrication:
 - 1. Shop fabricate ductwork of gauges and reinforcement complying with the more stringent of the following standards, except as noted herein.
 - a. SMACNA HVAC Duct Construction Standards
 - b. California Mechanical Code
 - 2. Fabricate ducts for 2 inch pressure class with minimum duct gauges and reinforcement as follows, except as otherwise noted:

<u>Table A</u>		
<u>Duct Dimension</u>	<u>Minimum Gauge</u>	<u>Joint Reinforcement Per CMC</u>
Through 12"	26	Not Required
13" through 18"	24	Not Required
19" through 30"	24	C/4
31" through 42"	22	E/4
43" through 54"	22	F/2

55" through 60"	20	G/4
61" through 84"	20	I/2
85" through 96"	20	J/2
Over 96"	18	K/2

3. Fabricate duct fittings to match adjoining ducts and to comply with duct requirements as applicable to fittings. Except as otherwise indicated, fabricate elbows with center-line radius equal to 1.5 times associated duct width. Fabricate to include single thickness turning vane in elbows where space does not permit the above radius or where square elbows are shown. Limit angular tapers to 30 degrees for contracting tapers and 20 degrees for expanding tapers. Turning vanes shall be E-Z Rail II, Durodyne, or equal.
 4. Fabricate round supply connections at rectangular, plenum type fittings using spin-in type fittings, complete with extractor and volume control damper. Refer to Paragraph "DAMPERS" for damper requirements.
 5. Provide drive slip or equivalent flat seams for ducts exposed in the conditioned space or where necessary due to space limitations. On ducts with flat seams, provide standard reinforcing on inside of duct. Duct connection to outlet on exposed duct shall be full size of outer perimeter of outlet flange.
 6. Ducts exposed in the conditioned space shall be free of dents and blemishes and be mounted tight against adjacent surface with flat hangers. Remove all fabrication labels from ductwork.
 7. Provide 20 gauge minimum for ductwork exposed within occupied spaces.
- K. Shop-Fabricated, Insulated, Rectangular, Double-Wall Ductwork for Outdoor Applications:
1. Provide insulated, double-wall ductwork for ducts conveying conditioned air, without internal lining, located outdoors.
 2. Inner Ducts: Fabricate ducts as specified for single-wall ducts, in gauges and with joint reinforcements given in Table A for 2-inch pressure class or comply with gauges and reinforcements given in SMACNA HVAC Duct Construction Standards (Metal and Flexible) for 4-inch pressure class, as applicable.
 3. Outer Ducts: Fabricate as described for inner ducts, except use gauges for the next higher duct size category.
 4. Reinforcement of Interstitial Space: Provide 18-gauge galvanized steel intermediate bracing at 24-inch intervals similar to that shown in 2005 (Third Edition) SMACNA HVAC Duct Construction Standards (Metal and Flexible), Figure 9-11. Attach bracing to inner and outer ducts with No. 8 sheet metal screws, 3 inches from corners, 6 inches on center.
 5. Interstitial Insulation: Fibrous glass insulation board is specified in Section 23 00 50. Insulation board shall be minimum R-13 at 3 inches thick. Spot-adhere boards to inner ducts with adhesive recommended by insulation board manufacturer. Butt boards square at corners. Seal joints between insulation boards with pressure-sensitive tape recommended by insulation manufacturer.
 - a. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1) Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - a) Childers Brand; H. B. Fuller Construction Products.
 - b) Eagle Bridges - Marathon Industries.
 - c) Foster Brand; H. B. Fuller Construction Products.

- d) Mon-Eco Industries, Inc.
 - 2) Fiberglass adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 3) Adhesive shall comply with testing and product requirements of South Coast Air Quality Management District, Rule 1168.
 - b. Provide cross-broken ductwork. Ensure that the ductwork will shed water.
 - 1) Ducts with horizontal dimension 12 inches and greater: Slope duct downward from longitudinal midpoint in two directions at 1/4 inch per foot. Duct slope shall not reduce duct airflow free area. Cross-breaking may be omitted for sloped duct surfaces.
- L. Rectangular Internally Insulated Duct Fabrication:
- 1. Provide internal duct lining where indicated on the Drawings, with a minimum of 10'-0" length in each direction from the fan, fan casing, or unit casing. Line all transfer ducts.
 - a. Where ductwork is exposed to weather or outside the building insulation envelope, provide 2 inch thick, 1-1/2 pound density internal lining with matte facing, with an R-Value of 8.0 minimum.
 - b. Where ductwork is within the building insulation envelope, lining shall be 1" thick, 1-1/2 pound density, with R-value of 4.2 minimum.
 - c. Ducts exposed in the conditioned space shall be free of dents and blemishes and be mounted tight against adjacent surface with flat hangers. Remove all fabrication labels from ductwork.
 - d. Where installed exposed in the conditioned space, duct shall be minimum 20 gauge with 1 inch insulation layer (minimum R-value – R-4.2).
 - e. Cement duct liner in place with nonflammable, non-hardening duct adhesive. Seal all raw edges of insulation inside ductwork with adhesive, including longitudinal liner edges.
 - f. Provide metal nosing at all locations where liner is preceded by unlined metal.
 - g. Provide sheet metal weld pins and washers or clinch pins and washers on all ductwork on 12 inch intervals with the first row within 3 inches of the leading edge of each piece of insulation and within 4 inches of corners. No use of adhesive mounted pins will be considered.
 - 1) Install clinched pin fasteners with properly adjusted automatic fastening equipment. Manual installation will not be considered.
 - 2) Install weld pins with properly adjusted automatic fastening equipment. Installation shall not damage the galvanized coating on the outside of the duct.
 - h. All ductwork, adhesives, lining, sealant, flex duct and the like shall have a flame spread of 25 or less and developed smoke rating of 50 or less when tested in accordance with one of the following test methods: NFPA 255, ASTM E84, or UL 723.
 - i. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:

<u>Manufacturer:</u>	<u>Product:</u>
Johns Manville	Linacoustic RC
CertainTeed Corporation	ToughGard

Fosters Adhesive	85-62
Swifts Adhesive	7336

- M. Round and Oval Ductwork Fabrication:
1. Round and oval duct and fittings shall be spiral lockseam or longitudinal seam as indicated in table below. Provide couplings to join each length of duct.
 - a. At contractors' option, round or oval ductwork may be utilized in place of rectangular ductwork shown on Drawings, provided available space allows for installation of round or oval ductwork without compromising space required for installation of products and systems of other trades.
 - 1) Round or oval ductwork utilized in place of rectangular ductwork shown on Drawings shall be sized to have a static pressure loss equivalent to rectangular duct shown on Drawings.
 - 2) Unlined round or oval duct shall not be utilized in place of rectangular internally lined ductwork shown on Drawings.
 2. Fabricate duct fittings to match adjoining ducts and to comply with duct requirements as applicable to fittings. Except as otherwise indicated, fabricate elbows with center-line radius equal to 1.5 times associated duct width. Provide two-piece, die-stamped, 45-degree to 90-degree elbows for sizes up to 12 inches; five-piece, 90-degree elbows for sizes 12 inches and above; conical tees; and conical laterals. All reducers shall be placed after a tap has been made on the duct main. Reducers shall be long-taper style.
 3. Round Ductwork: Construct of galvanized sheet steel complying with ANSI/ASTM A 653 by the following methods and in minimum gauges listed.

<u>Diameter</u>	<u>Minimum Gauge</u>	<u>Method of Manufacture</u>
Up to 14"	26	Spiral Lockseam
15" to 23"	24	Spiral Lockseam
24" to 36"	22	Spiral Lockseam
37" to 50"	20	Spiral Lockseam
51" to 60"	18	Spiral Lockseam
Over 60"	14	Longitudinal Seam

4. Provide locked seams for spiral duct; fusion welded butt seam for longitudinal seam duct.
5. Fittings and Couplings: Construct of minimum gauges listed. Provide continuous welds along seams at exposed ducts. Provide spot weld bonded seams at concealed ducts.

<u>Diameter</u>	<u>Minimum Gauge</u>
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3" to 36"	20
38" to 50"	18
Over 50"	16

6. Ducts exposed in the conditioned space shall be free of dents and blemishes and be mounted tight against adjacent surface with flat hangers. Remove all fabrication labels from ductwork.
7. Provide 20 gauge minimum for ductwork exposed within occupied spaces.

N. Round Internally Insulated Duct and Fittings: Where ductwork is exposed to weather or outside the building insulation envelope, construct with outer pressure shell, 2 inch thick (Minimum R-value = R-8) insulation layer, and perforated inner liner. Where ductwork is within the building insulation envelope, construct with outer pressure shell, 1 inch thick (minimum R-value = R4.2) insulation layer, and perforated inner liner. Construct shell and liner of galvanized sheet steel complying with ANSI/ASTM A 653, of spiral lockseam construction (use longitudinal seam for over 59 inches), in minimum gauges listed in table below. Where installed exposed in the conditioned space: duct and fitting outer pressure shell shall be minimum 20 gauge with 1 inch insulation layer (minimum R-value = R-4.2), and perforated inner liner.

<u>Nominal Duct Diameter</u>	<u>Outer Shell</u>	<u>Inner Liner</u>
3" TO 12"	26 gauge	24 gauge
13" TO 24"	24 gauge	24 gauge
25" to 34"	22 gauge	24 gauge
35" to 48"	20 gauge	24 gauge
49" to 58"	18 gauge	24 gauge
Over 59"	16 gauge	20 gauge

1. Fittings and Couplings: Construct of minimum gauges listed. Provide continuous weld along seams of outer shell at exposed ducts. Provide spot weld bonded seams at concealed ducts.

<u>Nominal Duct Diameter</u>	<u>Outer Shell</u>	<u>Inner Liner</u>
3" to 34"	20 gauge	24 gauge
36" to 48"	18 gauge	24 gauge
Over 48"	16 gauge	24 gauge

2. Inner Liner: Perforate with 3/32 inch holes for 22 percent open area. Provide metal spacers welded in position to maintain spacing and concentricity.
 3. Ducts exposed in the conditioned space shall be free of dents and blemishes and be mounted tight against adjacent surface with flat hangers. Remove all fabrication labels from ductwork.
 4. Where installed exposed in the conditioned space, duct shall be minimum 20 gauge with 1 inch insulation layer (minimum R-value – R-4.2).
 5. All ductwork, adhesives, lining, sealant, flex duct and the like shall have a flame spread of 25 or less and developed smoke rating of 50 or less when tested in accordance with one of the following test methods: NFPA 255, ASTM E84, or UL 723.
 6. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - a. Sheet Metal Div., McGill AirFlow, LLC., Acousti-k27
 - b. Semco Duct and Acoustical Products, Inc.
 - c. Air Systems Manufacturing, Inc. - Las Vegas
- O. Duct Access Doors:
1. Duct Access: Provide hinged access door in rectangular ducts for access to fire dampers, control equipment, etc. Access door size shall be duct diameter wide by duct diameter high for all ducts under 24 inches. Ducts over 24 inches in diameter shall have 24-inch by 18-inch access doors. Minimum size access doors shall be 6 inches by 6 inches.
 2. Provide hinged style access doors for round ductwork, NCA Manufacturing, Inc., Model AD-RD-87, Pottorff Series 60, or equal. Access doors shall be 16 gauge galvanized steel with continuous piano hinge. Locks shall be plated steel strike and catch. Provide 1" x 3/8" Polyethylene "Perma Stik" gasket all around door.
- P. Flexible Air Ducts:
1. Provide exterior reinforced laminated vapor barrier, fiberglass insulation, encapsulated spring steel wire Helix, and impervious, smooth, non-perforated interior vinyl liner. Individual lengths of flexible ducts shall contain factory fabricated steel connection collars.
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - 1) C.A. Schroeder, Inc., Cal Flex model 2PMJ.
 - 2) ThermaFlex model M KC.
 2. Factory made air ducts shall be approved for the use intended and shall conform to the requirements of UL 181 and NFPA 90A. Each portion of a factory-made air duct system shall be identified by the manufacturer with a label or other suitable identification indicating compliance with UL 181, Class 1. Ducts shall be UL listed Class 1, maximum 25/50 smoke and flame spread and shall be installed in accordance with the terms of their listing and the requirements of SMACNA HVAC Duct Construction Standards (Metal and Flexible). Factory-made air ducts shall have the following minimum R-values: R-6.0 for ductwork installed within the building insulation envelope, R-8.0 for ductwork installed outside the building insulation envelope.
 3. Flexible ductwork shall be maximum of 8 feet long, and shall be extended to the fullest possible length, in order to minimize pressure drop in the duct.
 4. Flexible ducts shall be selected for minimum of 6 inch positive static pressure and minimum of 1 inch negative static pressure.
- Q. Shower exhaust ducts: Provide ducts and supports from stainless steel for a length of 20 feet from exhaust grille or register.

- R. Provide Ventlon, or equal, flexible connections on inlet and outlet of AC Unit, air handler and exhaust fans. Provide galvanized weather hood over flexible connections exposed to the weather.

2.13 HYDRONIC PIPING

- A. Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, temperature ratings, and capacities as indicated. Provide materials and products complying with California Mechanical Code. Where more than one type of material or product is indicated, selection from materials or products specified is Contractor's option.
- B. Chilled Water, Heating Hot Water, and Condenser Water Piping:
 - 1. Copper Tube and Fittings Aboveground:
 - a. Copper Tube and Fittings Aboveground: ASTM B88, Type L, drawn-temper, 150 psig minimum working pressure at 200 deg. F. Provide wrought-copper fittings and unions, ASTM B16.22, with full solder cup. Capped outlets shall be Schedule 40 screwed brass.
 - 2. Steel Pipe and Fittings Aboveground:
 - a. 2 inches and smaller: ASTM A 53/A 53M, Schedule 40 black steel with plain ends, 150 psig minimum working pressure at 200 deg. F. Provide malleable-iron threaded fittings, ASTM B16.3, Class 150, and unions, ASTM B16.39, Class 150, and cast-iron flanges and flange fittings, and threaded joints.
 - b. 2-1/2 inches and larger: ASTM A 53/A 53M, Schedule 40 black steel with plain ends, 150 psig minimum working pressure at 200 deg. F. Provide wrought-steel fittings, ASTM A 234/A 234M, and wrought-cast or forged-steel flanges and flange fittings, ASME B16.5, material group 1.1, with butt welding end connections and raised face.
 - 3. Underground Hydronic Piping:
 - a. Refer to Section 23 21 13.13, Underground Hydronic Piping.

2.14 HYDRONIC PUMPS

- A. Close-Coupled, End Suction Centrifugal Pumps
 - 1. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, cast iron, bronze-fitted, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally.
 - 2. Pump Construction:
 - a. Casing: Radially split, cast iron, drain plug at bottom and air vent at top of volute, threaded gage tappings at inlet and outlet, and flanged connections.
 - b. Impeller: ASTM B 584, cast bronze or cast brass; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For constant-speed pumps, trim impeller to match specified performance.
 - c. Pump Shaft: Steel, with copper-alloy shaft sleeve.
 - d. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket. Include water slinger on shaft between motor and seal.
 - e. Pump Bearings: Permanently lubricated or grease lubricated ball bearings as normally furnished for pump size scheduled on Drawings.
 - 3. Motor: Single speed and rigidly mounted to pump casing with integral pump support.
 - a. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 1) Enclosure: Open, dripproof Totally enclosed, fan cooled Explosion proof.
 - 2) Enclosure Materials: Rolled steel.

- 3) Motor Bearings: Permanently lubricated or grease-lubricated ball bearings as normally furnished for pump size scheduled on Drawings.
 - 4) Efficiency: Premium efficient.
 4. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ITT Corporation; Bell & Gossett.
 - b. Armstrong Pumps Inc.
 - c. PACO Pumps.
 - d. TACO Incorporated.
- B. Separately Coupled, Base-Mounted, End-Suction Centrifugal Pumps
1. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, cast iron, bronze-fitted, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal.
 2. Pump Construction:
 - a. Casing: Radially split, cast iron, drain plug at bottom and air vent at top of volute, threaded gage tapings at inlet and outlet, and flanged connections.
 - b. Impeller: ASTM B 584, cast bronze or cast brass; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For constant-speed pumps, trim impeller to match specified performance.
 - c. Pump Shaft: Steel, with copper-alloy shaft sleeve.
 - d. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket. Include water slinger on shaft between motor and seal.
 - e. Pump Bearings: Permanently lubricated or grease lubricated ball bearings as normally furnished for pump size scheduled on Drawings.
 3. Shaft Coupling: Replaceable molded-rubber insert and interlocking spider capable of absorbing vibration. Provide EPDM coupling sleeve for variable-speed applications.
 4. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.
 5. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A 36/A 36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.
 6. Motor: Single speed and secured to mounting frame, with adjustable alignment.
 - a. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 1) Enclosure: Open, dripproof Totally enclosed, fan cooled explosion proof.
 - 2) Enclosure Materials: Rolled steel.
 - 3) Motor Bearings: Permanently lubricated or grease-lubricated ball bearings as normally furnished for pump size scheduled on Drawings.
 - 4) Efficiency: Premium efficient.
 7. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ITT Corporation; Bell & Gossett.
 - b. Armstrong Pumps Inc.
 - c. PACO Pumps.
 - d. TACO Incorporated.
- C. Close-Coupled, In-Line Centrifugal Pumps
1. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, cast-iron, bronze fitted in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally or vertically.

2. Pump Construction:
 - a. Casing: Radially split, cast iron, drain plug at bottom and air vent at top of volute, threaded gage tappings at inlet and outlet, and flanged connections.
 - b. Impeller: ASTM B 584, cast bronze or cast brass; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For constant-speed pumps, trim impeller to match specified performance.
 - c. Pump Shaft: Steel, with copper-alloy shaft sleeve.
 - d. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket. Include water slinger on shaft between motor and seal.
 - e. Pump Bearings: Permanently lubricated or grease lubricated ball bearings as normally furnished for pump size scheduled on Drawings.
 3. Motor: Single speed and rigidly mounted to pump casing.
 - a. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 1) Enclosure: Open, dripproof Totally enclosed, fan cooled explosion proof.
 - 2) Enclosure Materials: Rolled steel.
 - 3) Motor Bearings: Permanently lubricated or grease-lubricated ball bearings as normally furnished for pump size scheduled on Drawings.
 - 4) Efficiency: Premium efficient.
 4. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ITT Corporation; Bell & Gossett.
 - b. Armstrong Pumps Inc.
 - c. PACO Pumps.
 - d. TACO Incorporated.
- D. Separately Coupled, Horizontally Mounted Centrifugal In-Line Pumps
1. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, cast-iron, bronze fitted in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally.
 2. Pump Construction:
 - a. Casing: Radially split, cast iron, drain plug at bottom and air vent at top of volute, threaded gage tappings at inlet and outlet, and flanged connections.
 - b. Impeller: ASTM B 584, cast bronze or cast brass; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For constant-speed pumps, trim impeller to match specified performance.
 - c. Pump Shaft: Steel, with copper-alloy shaft sleeve.
 - d. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket.
 - e. Pump Bearings: Permanently lubricated ball bearings.
 3. Shaft Coupling: Replaceable molded-rubber insert with interlocking spider.
 4. Motor: Single speed and resiliently mounted to pump casing.
 - a. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 1) Enclosure: Open, dripproof Totally enclosed, fan cooled explosion proof.
 - 2) Enclosure Materials: Rolled steel.
 - 3) Motor Bearings: Permanently lubricated or grease-lubricated ball bearings as normally furnished for pump size scheduled on Drawings.
 - 4) Efficiency: Premium efficient.

5. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ITT Corporation; Bell & Gossett.
 - b. Armstrong Pumps Inc.
 - c. PACO Pumps.
 - d. TACO Incorporated.

2.15 HYDRONIC BOILERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following, or equal:
 1. Laars Heating Systems Company.
 2. Lochinvar, LLC.
 3. Triangle Tube.
- B. Description: Factory-fabricated, -assembled, and -tested, copper-finned, water-tube condensing boiler with heat exchanger sealed pressure tight, built on a steel base, including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls. Water-heating service only.
- C. Heat Exchanger: Finned-copper primary and stainless-steel secondary heat exchangers.
- D. Combustion Chamber: Stainless steel, sealed.
- E. Burner: Natural gas, forced draft drawing from gas premixing valve.
- F. Blower: Centrifugal fan to operate during each burner firing sequence and to prepurge and postpurge the combustion chamber.
 1. Motors: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - a. Motor Sizes: Minimum size as indicated; if not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
- G. Gas Train: Combination gas valve with manual shutoff and pressure regulator.
- H. Ignition: Silicone carbide hot-surface ignition that includes flame safety supervision and 100 percent main-valve shutoff.
- I. Integral Circulator: Cast-iron body and stainless-steel impeller sized for minimum flow required in heat exchanger.
- J. Casing:
 1. Jacket: Sheet metal, with snap-in or interlocking closures.
 2. Control Compartment Enclosures: NEMA 250, Type 1A.
 3. Finish: Textured epoxy.
 4. Insulation: Minimum 1-inch thick, mineral-fiber insulation surrounding the heat exchanger.
 5. Combustion-Air Connections: Inlet and vent duct collars.
- K. Each boiler shall be provided with all necessary trim:
 1. Safety relief valve shall be provided in compliance with the ASME code. Contractor to pipe to acceptable drain.
 2. Water pressure-temperature gauge.

3. Primary low water flow fuel cutoff (probe type with manual reset).
 4. Manual reset high limit water temperature controller.
 5. Operating temperature control to control the sequential operation of the burner.
 6. Separate inlet and outlet water temperature sensors capable of monitoring flow
 7. Exhaust temperature sensor.
 8. Each boiler shall be provided with an integral, fully modulating, main gas valve train.
 9. Each boiler shall be equipped for direct spark ignition
 10. Each boiler shall be provided with an integral combustion air control system. The primary control shall vary the speed of the blower based on load demand.
- L. Vent: Fabricate vent connectors from ASTM B 209 (ASTM B 209M), Type 1100 or 3003, stainless steel, complying with NFPA 211 with a minimum metal thicknesses of 0.012 inches.
- M. Controls: Each boiler shall be provided with all necessary controls, all necessary programming sequences, and all safety interlocks. Each boiler control system shall be properly interlocked with all safeties.

2.16 AIR COOLED CHILLERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following, or equal:
1. Carrier Corporation; a unit of United Technologies Corp.
 2. Daikin Applied.
 3. Dunham-Bush.
 4. Trane.
 5. YORK; a Johnson Controls company.
- B. Products shall be Designed, Tested, Rated and Certified in accordance with, and Installed in compliance with applicable sections of the following Standards and Codes:
1. AHRI 550/590 – Water Chilling Packages Using the Vapor Compression Cycle
 2. AHRI 370 – Sound Rating of Large Outdoor Refrigerating and Air-Conditioning Equipment
 3. ANSI/ASHRAE 15 – Safety Code for Mechanical Refrigeration
 4. ANSI/NFPA 70 – National Electrical Code (N.E.C.)
 5. ASME Boiler and Pressure Vessel Code, Section VIII, Division 1
 6. OSHA – Occupational Safety and Health Act
 7. Manufactured in facility registered to ISO 9001
 8. ETL/cETL Listed
- C. Special Warranty: Five years from date of Substantial Completion.
- D. Factory Run Test: Chiller shall be pressure-tested, evacuated and fully charged with refrigerant and oil, and shall be factory operational run tested with water flowing through the vessel.
- E. Description: Furnish, Install, and Commission factory assembled, charged, and operational run tested air-cooled screw compressor chiller. Chiller shall include, but is not limited to: a complete system with multiple independent refrigerant circuits, semi hermetic twin screw compressors, shell and tube hybrid falling film type evaporator, air-cooled condenser, R134a refrigerant, lubrication system, interconnecting wiring, safety and operating controls including capacity controller, control center, motor starting components, and special features as specified herein or required for safe, automatic operation.
- F. Operating Characteristics: Provide low and high ambient temperature control options as required to ensure unit is capable of operation from 0°F to 125°F (-18°C to 52°C) ambient temperature. Provide capacity control system capable of reducing unit capacity to 10% of full

load for 2 compressor units. Compressor shall start in unloaded condition. Application of factory installed hot gas bypass shall be acceptable as required to meet specified minimum load.

- G. Cabinet: Unit panels, structural elements, control boxes and heavy gauge structural base shall be constructed of painted galvanized steel. All exposed sheet steel shall be coated with baked on powder paint to meet 500-hour salt spray test
- H. Compressors:
 - 1. Description: Positive displacement, hermetically sealed.
 - 2. Casing: Cast iron, precision machined for minimum clearance about periphery of rotors.
 - 3. Rotors: Manufacturer's standard one- or two-rotor design.
 - 4. Each compressor provided with suction and discharge shutoff valves, crankcase oil heater, and suction strainer.
- I. Compressor Motors: Refrigerant suction-gas cooled accessible hermetic compressor motor, full suction gas flow through 0.006" (0.1524 mm) maximum mesh screen, with inherent internal thermal overload protection and external current overload on all three phases.
- J. Balancing Requirements: All rotating parts shall be statically and dynamically balanced.
- K. Lubrication System: External oil separators with no moving parts, 450 psig (31 barg) design working pressure, and ETL listing shall be provided on the chiller. Refrigerant system differential pressure shall provide oil flow through service replaceable, 0.5 micron, full flow, cartridge type oil filter internal to compressor. Filter bypass, less restrictive media, or oil pump not acceptable.
- L. Capacity Control: Compressors shall start at minimum load. Provide Microprocessor control to command compressor capacity to balance compressor capacity with cooling load.
- M. Refrigerant circuit components:
 - 1. Refrigerant: R-134a. Classified as Safety Group A1 according to ASHRAE 34
 - 2. Each independent refrigerant circuit shall incorporate all components necessary for the designed operation including: liquid line shut-off valve with charging port, low side pressure relief device, removable core filter-drier and sight glass with moisture indicator.
 - 3. Chiller manufacturer shall provide an independent circuit for each compressor to provide maximum redundancy during chiller operation. If equipment does not have independent circuits per compressor, manufacturer shall provide owner one spare compressor of each unique size.
 - 4. Discharge lines shall be provided with manual compressor shut-off service valves.
 - 5. Provide a minimum of one circuit with hot gas bypass.
- N. Evaporator:
 - 1. Evaporator shall be shell and tube. Tubes shall be high-efficiency, internally and externally enhanced type copper tubes with 0.035" (0.89 mm) minimum wall thickness at all intermediate tube supports to provide maximum tube wall thickness at the support area. Each tube shall be roller expanded into the tube sheets providing a leak proof seal, and be individually replaceable. Independent refrigerant circuits shall be provided per compressor.
 - 2. Constructed, tested, and stamped in accordance with applicable sections of ASME pressure vessel code for minimum 235 psig (16 barg) refrigerant side design working pressure and 150 psig (10 barg) liquid side design working pressure.
 - 3. Water boxes shall be removable to permit tube cleaning and replacement. Water boxes shall include liquid nozzle connections suitable for ANSI/ AWWA C-606 couplings, welding, or flanges.

4. Provide vent and drain fittings, and thermo-statically controlled heaters to protect to 0°F (-17.8°C) ambient temperature in off-cycle.
- O. Air-cooled Condenser:
1. Condenser coils shall be microchannel type, parallel flow aluminum alloy tubes metallurgically brazed as one piece to enhanced aluminum alloy fins. Condenser coils shall be made of a single material to avoid galvanic corrosion due to dissimilar metals. Tube and fin type condenser coils are an acceptable alternate when tubes and fins are fabricated of the same metal material to avoid galvanic corrosion due to dissimilar metals. Coils shall be designed for 350 psig (24 barg) or higher working pressure.
 2. Post-coated epoxy dipped condenser microchannel: The unit shall be built with microchannel sections that have been applied with an electro-deposited and baked flexible epoxy coating that is finished with a polyurethane UV resistant top-coat suitable for highly corrosive applications.
 3. Louvered/Wire Panels: Louvered steel panels on external condenser coil faces, painted to match unit panels. Heavy gauge, welded wire mesh, coated to resist corrosion, around base of machine to restrict unauthorized access.
 4. Low Sound Fans: Shall provide vertical air discharge from extended orifices. Fans shall be composed of corrosion resistant aluminum hub and glass-fiber-reinforced polypropylene composite blades molded into a low-noise airfoil section. Fan impeller shall be dynamically balanced for vibration-free operation. Fan guards of heavy gauge galvanized steel.
 5. Fan Motors: High efficiency, direct drive, 3-phase, insulation class "F", current protected, Totally Enclosed Air-Over (TEAO), with double sealed, permanently-lubricated ball bearings. Open Drip Proof (ODP) fan motors will not be acceptable.
- P. Insulation:
1. Material: Closed-cell, flexible, UV protected, thermal insulation complying with ASTM C 534 Type 2 (Sheet) for preformed flexible elastomeric cellular thermal insulation in sheet and tubular form.
 2. Thickness: 3/4" (19mm.)
 3. Thermal conductivity: 0.26 (BTU/HR-Ft²-°F/in) maximum at 75°F mean temperature.
 4. Factory-applied insulation over cold surfaces of liquid chiller components including evaporator shell, water boxes, and suction line. Liquid nozzles shall be insulated by Contractor after pipe installation.
 5. Adhesive: As recommended by insulation manufacturer and applied to 100 percent of insulation contact surface including all seams and joints.
- Q. Acoustical Data:
1. Provide acoustical sound power or sound pressure level data in decibels (dB) at the scheduled eight (8) octave band center frequencies. A-weighted sound data alone is not acceptable.
 2. Provide all sound power or sound pressure level data at 100%, 75%, 50%, and 25% load.
 3. Acoustical performance ratings shall be in accordance with AHRI Standard 370.
- R. Power and Electrical Requirements:
1. Power/Control Panel: Factory installed and wired NEMA 3R, powder painted steel cabinets with tool lockable, hinged, latched, and gasket sealed outer doors equipped with wind struts for safer servicing. Provide main power connection(s), compressor starters and fan motor contactors, current overloads, and factory wiring. Panel shall include control display access door.
 2. Single Point Circuit Breaker: A unit-mounted Circuit Breaker with external lockable handle shall be supplied to isolate power voltage for servicing. Incoming power wiring must comply with local codes. Circuit breaker shall be sized to provide the motor branch circuit

protection, short circuit protection and ground fault protection for the motor branch-circuit conductors, the motor control apparatus and the motors.

3. Control Transformer: Power panel shall be supplied with a factory mounted and wired control transformer that will supply all unit control voltage from the main unit power supply. Transformer shall utilize scheduled line voltage on the primary side and provide 115V/1Ø on secondary.
 4. Motor Starters: Motor starters shall be zero electrical inrush current (Variable Frequency Drives) for minimum electrical inrush. Open transition Wye-Delta and Across the Line type starters will not be acceptable.
 5. Power Factor: Provide equipment with power factor correction capacitors as required to maintain a displacement power factor of 95% at all load conditions.
 6. All exposed power wiring shall be routed through liquid-tight, UV-stabilized, non-metallic conduit.
- S. Controls:
1. Provide automatic control of chiller operation including compressor start/stop and load/unload, anti-recycle timers, condenser fans, evaporator pump, evaporator heater, unit alarm contacts and run signal contacts.
 2. Chiller shall automatically reset to normal chiller operation after power failure.
 3. Unit operating software shall be stored in non-volatile memory. Field programmed set points shall be retained in lithium battery backed regulated time clock (RTC) memory for minimum 5 years.
 4. Alarm contacts shall be provided to remote alert for any unit or system safety fault.
 5. Provide minimum 80 character liquid crystal display that is both viewable in direct sunlight and has LED backlighting for nighttime viewing.
 6. System Safeties: Shall cause individual compressor systems to perform auto-reset shut down if: high discharge pressure or temperature, low suction pressure, low motor current, high/low differential oil pressure, low discharge superheat, high motor temperature, system control voltage.
 7. Unit Safeties: Shall be automatic reset and cause compressors to shut down if: high or low ambient temperature, low leaving chilled liquid temperature, under voltage, flow switch operation. Contractor shall provide flow switch and wiring per chiller manufacturer requirements.
 8. Gateway: Provides BACnet (MS/TP), communication for Building Automation Systems.
- T. Vibration Isolation:
1. Elastomeric isolators.

2.17 PIPE JOINING MATERIALS

- A. Refer to Division 22 and 23 piping sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated
 - a. Full-Face Type: For flat-face, Class 125, cast iron and cast bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast iron and steel flanges.
 2. AWWA C111, rubber, flat face, 1/8-inch (3.2mm) thick, unless otherwise indicated; and full-face or ring type, unless other indicated.
 3. Flange Bolts and Nuts: AWWA C111, carbon steel, unless otherwise indicated.
- C. Brazing Filler Metals:
1. General Duty: AWS A5.8, BCup-5 Series, copper-phosphorus unless otherwise indicated. Sil-Fos 15, or equal.

2. Refrigerant Piping:
 - a. Joining copper to copper: AWS A5.8, BCup-5 Series, copper-phosphorus unless otherwise indicated. Sil-Fos 15, or equal.
 - b. Joining copper to bronze or steel: AWS A5.8, Bag-1, silver alloy unless otherwise indicated.

- D. Welding Filler Metals: Comply with ASME B31.1 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.18 VALVES

- A. Gate Valves:
 1. 2-1/2 inches and smaller: Class150, bronze body, union bonnet, rising stem, solid wedge, threaded or solder ends, conforming to MSS SP-80. Hammond IB641, IB648, Nibco T-134, S-134, Milwaukee 1151, 1169, or equal.
 2. 3 inches and larger: Class 125, iron body, bronze mounted, bolted bonnet, non-rising stem, solid wedge, flanged ends, conforming to MSS SP-70. Hammond IR-1138, Nibco F619, Milwaukee F2882A, Stockham G-612, or equal.
 3. Underground valves 2 inches thru 12 inches: 250 psi, iron body, Non-rising stem, bolted bonnet, resilient wedge valves, conforming to AWWA C509, equipped with operating nuts, Mueller Series 2360, Nibco F-619-RW-SON, or equal.
 - a. Underground valves 3 inches and smaller may be furnished with operating nuts or hand-wheels, and with Ring-Tite joint ends.
 - b. Furnish and deliver to Owner one wrench of each size required for operating underground valves.

- B. Ball Valves:
 1. 2 inches and smaller: 600 psi CWP, 150 psi SWP, cast bronze body, full port, two piece, threaded ends, and reinforced PTFE seal, conforming to MSS SP-110. Nibco T585-70, Milwaukee BA-400, Stockham T-285, or equal.
 2. 2-1/2 inches and larger: Class 150, carbon steel body, full port, two piece, stainless steel vented ball, flanged ends, and reinforced PTFE seal, conforming to MSS SP-72. Nibco F-515-CS-F-66-FS, Milwaukee F20-CS-15-F-02-GO-VB, or equal.
 3. Compressed Air Services: Class 150, bronze body, full port, three piece, threaded ends, and reinforced PTFE seal, conforming to MSS SP-110. Nibco Model T-595-Y, Milwaukee BA-300, or equal.

- C. Swing Check Valves: Class 125 or 150, bronze body, suitable for regrinding, threaded ends, conforming to MSS SP-80. Stockham B-321, Milwaukee 509, or equal.

- D. Butterfly Valves:
 1. General: Tight closing, full lug type, with resilient seat suitable for minimum working pressure of 200 psig, conforming to MSS SP-67. Bi-direction dead end service with downstream flange removed.
 2. Provide valves with the following:
 - a. Seats: Suitable for 40 degrees F for cold water service and 250 degrees F for hot water service. Seats shall cover inside surface of body and extend over body ends.
 - b. Bodies: Ductile iron or cast iron.
 - c. Discs: Bronze or stainless steel.
 - d. Stems or Shafts: Stainless steel.
 - e. Control Handles: Suitable for locking in any position or with 10 degree or 15 degree notched throttling plates to hold valve in selected position. Provide extended necks to compensate for insulation thickness. Provide gear operator for valves 5 inches and larger.

3. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - a. 2 through 12 inches: Milwaukee Valve, CL series, Nibco, Inc., model LD2000-3, or equal.
- E. Silent Check Valves (for use on pump discharge):
 1. General: Provide spring loaded check valves at pump discharge of all pumps.
 - a. 2 inches and smaller: 250 psi CWP, bronze body, Nibco Model T-480, Milwaukee 548-T, or equal.
 - b. 2-1/2 inches and larger: Class 250, cast iron body, wafer style, suitable for regrinding. Nibco Model F960, Milwaukee 1400, Mueller 103MAP, or equal.
- F. Calibrated Balance Valves (Symbol CBV): Provide globe style valves for precision regulation and control rated 175 psi for sizes 2-1/2 inches through 12 inches and rated 240 psi for bronze sizes 2 inches and below. Each valve shall have two metering/test ports with internal check valves and protective caps. All valves must be equipped with visual position readout and concealed memory stops for repeatable regulation and control.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 - a. Bell & Gossett Circuit Setter Plus.
 - b. Armstrong CBV.
 - c. Flow Design Inc. Accusetter.
 - d. Tour & Andersson.
 - e. Circuit Sensor with butterfly valve above 3 inches.
 - f. Illinois Series 5000 through 2 inches.
- G. Flow Control Valve: Automatic pressure compensating flow control valves shall be Griswold, Flow Design, Inc., or equal.
- H. Air Vent Valves:
 1. Provide Armstrong #1AV, Hoffman Model 78, Metraflex Model MV-15A, or equal, where automatic type air vent is shown.

2.19 RADIANT HEATERS

- A. Provide radiant ceiling panels in locations as indicated and with capacities, style, and accessories as scheduled. The panels shall be UL or ETL listed.
- B. Construct panels using 24 gauge minimum galvanized or painted steel.
- C. Provide a support frame with mounting brackets.
- D. Provide with manufacturer's thermostat.
- E. Mount at height per architectural requirements.
- F. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
 1. BBC Industries, Inc.

2.20 EXPANSION TANKS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:

1. AMTROL, Inc.
 2. Armstrong Pumps, Inc.
 3. Bell & Gossett; a Xylem brand.
 4. TACO Comfort Solutions, Inc.
- B. Tank: Welded steel, rated for 125-psig working pressure and 375 deg F maximum operating temperature. Factory test after taps are fabricated and supports installed and are labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- C. Diaphragm: Heavy duty butyl, securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
- D. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.

2.21 AIR SEPARATORS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or equal:
1. AMTROL, Inc.
 2. Armstrong Pumps, Inc.
 3. Bell & Gossett; a Xylem brand.
 4. TACO Comfort Solutions, Inc.
- B. Tank: Welded steel; ASME constructed and labeled for 125-psig minimum working pressure and 375 deg F maximum operating temperature.
- C. Air Collector Tube: Perforated stainless steel, constructed to direct released air into expansion tank.
- D. Tangential Inlet and Outlet Connections: Threaded for NPS 2 and smaller; flanged connections for NPS 2-1/2 and larger.
- E. Blowdown Connection: Threaded.

2.22 TEMPERATURE CONTROL SYSTEM

- A. Refer to Section 23 09 00 Instrumentation and Control for HVAC.

PART 3 - EXECUTION

3.1 ROOF MOUNTED EQUIPMENT INSTALLATION

- A. Mount and anchor equipment in strict compliance with Drawings details. Alternate anchorage methods will not be considered for roof mounted equipment.
- B. Examine rough-in for roof mounted equipment to verify actual locations of piping and duct connections prior to final equipment installation.
- C. Verify that piping to be installed adjacent to roof mounted equipment allows service and maintenance.
- D. Verify that gas piping will be installed with sufficient clearance for burner removal and service.

- E. Install ducts to termination at top of roof curb and install heavy duty rubber gaskets on supply and return openings and on full perimeter of curb, or as required for an airtight installation, prior to setting unit on curb.
- F. Cover roof inside each roof mounted air conditioning unit, heat pump unit, and heating and ventilating unit roof curb with 2 inch thick, 3 pound density fiberglass insulation board.
- G. Connect supply and return air ducts to horizontal discharge roof mounted equipment with flexible duct connectors specified elsewhere in these Specifications.
- H. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.

3.2 SPLIT SYSTEM AC, HEAT PUMP, AND VRF SYSTEMS INSTALLATION

- A. General:
 - 1. Install units level and plumb.
 - 2. Install evaporator-fan components as detailed on Drawings.
 - 3. Install ground or roof- mounted condensing units as detailed on Drawings.
 - 4. Install seismic restraints as required by applicable codes. Refer to Article, Submittals, in Section 23 00 50, Basic HVAC Materials and Methods, for delegated design requirements for seismic restraints.
 - 5. Install and connect refrigerant piping as detailed in unit manufacturers' literature. Install piping to allow access to unit.
 - 6. Install cooling coil condensate primary drain pan piping, and overflow, if provided, and run to nearest code-compliant receptacle, or as indicated on Drawings. Install secondary drain pan for units installed over permanent and suspended-tile ceilings. Install secondary drain pan piping and terminate 1/2 inch below ceiling, with escutcheon, in a readily visible location or as shown on Drawings.
 - 7. Install air filters at each indoor unit. Install washable, permanent filters at indoor units designed to accept washable, permanent filters. Refer to Drawings schedule, and Article, Air Filters, in this Section, for filter requirements for ducted, above-ceiling units incorporating mixing boxes.
 - 8. Duct Connections: Duct installation requirements are specified in Article, Ductwork, in this Section. Drawings indicate the general arrangement of ducts. Connect supply and return ducts to split-system air-conditioning units with flexible duct connectors. Flexible duct connectors are specified in Article, Ductwork, in this Section.

3.3 REFRIGERANT PIPING INSTALLATION

- A. General:
 - 1. Install refrigerant piping according to ASHRAE 15. Install and connect refrigerant piping as detailed in unit manufacturers' literature. Install piping to allow access to unit.
 - 2. Install piping straight and free of kinks, restrictions or traps.
 - 3. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
 - 4. Slope horizontal suction piping 1 inch/10 feet towards compressor.
 - 5. Install fittings for changes in direction and branch connections.
 - 6. Piping under raised floors shall be kept 6 inches minimum above ground; excavate as necessary.
 - 7. Install locking caps on refrigerant access valves located outside building, including valves located on roofs.

8. Insulate refrigerant piping, including liquid and hot gas pipes when required by system manufacturer, and including headers, branches, and other components as detailed in unit manufacturers' literature. Refer to Article, Insulation Work, in Section 23 00 50, Basic HVAC Materials and Methods.
- B. Factory Pre-charged and sealed line set piping:
 1. Keep the entire system clean and dry during installation.
 2. All tubing shall be evacuated and sealed at the factory. The seal must not be broken until ready for assembly.
 3. If there is any evidence of dust, moisture, or corrosion, the tubing must be cleaned out by drawing a swab soaked with methyl alcohol through the tubing as many times as necessary to thoroughly clean the tubing.
 4. Where line set piping is used, enclose in iron or steel piping and fittings or in EMT conduit.
- C. Field Assembled Refrigerant Piping:
 1. Select system components with pressure rating equal to or greater than system operating pressure.
 2. Where subject to mechanical injury, enclose refrigerant piping in EMT conduit.
 3. When brazing, remove solenoid valve coils and sight glasses, also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

3.4 FAN INSTALLATION

- A. Ceiling Mounted Fans: Mount variable speed switch within fan housing. Mark final balance point on variable speed switch.
- B. Provide access doors for fans or motors mounted in ductwork.
- C. Mount all fans as detailed on Drawings and in compliance with CBC standards.
- D. Fan motors mounted in air-stream to be totally enclosed.
- E. Completely line supply, return or exhaust fan cabinets with 1 inch thick, 3/4 pound density acoustic insulation securely cemented in place.
- F. Roof fans shall be mounted level.
- G. Provide heavy-duty rubber gasket between exhaust fan mounting flange and roof curb, or as required for an airtight installation.

3.5 RELIEF VENT INSTALLATION

- A. Install relief vents to provide a level mounting for backdraft damper.

3.6 AIR INLETS AND OUTLETS INSTALLATION

- A. Provide all air inlets and outlets with gaskets and install so that there will be no streaking of the walls or ceilings due to leakage. Duct connection to outlet on exposed duct shall be full size of outer perimeter of outlet flange.

- B. Unless otherwise indicated on Drawings, provide rectangular galvanized steel plenum on top of each diffuser and ceiling return for connection to ductwork. Line plenum with internal insulation as indicated for lined ductwork. Size plenum to allow full opening into air terminal. Plenum sheet metal gauge shall be equal to gauge for rectangular equivalent of the branch duct serving the air inlet or outlet.
- C. Ceiling-mounted air inlets, outlets, or other services installed in T-Bar type ceiling systems shall be positively attached to the ceiling suspension main runners or to cross runners with the same carrying capacity as the main runners.
 - 1. Air inlets, outlets, or other services weighing not more than 56 pounds shall have two No. 12 gauge hangers connected from the terminal or service to the structure above. These wires may be slack.
 - 2. Support air inlets, outlets, or other services weighing more than 56 pounds directly from the structure above by approved hangers. Provide 4 taut 12 gauge wires each, attached to the fixture and to the structure above. The 4 taut 12 gauge wires, including their attachment to the structure above must be capable of supporting 4 times the weight of the unit.
 - 3. Secure air inlets and outlets to main runners of ceiling suspension system with two No. 8 sheet metal screws at opposing corners.
- D. Furnish all air inlets and outlets with a baked prime coat unless otherwise noted. Provide off-white baked enamel finish on ceiling-mounted air inlets and outlets. Paint exposed mounting screws to match the material being secured.
- E. Air inlets and outlets shall match all qualities of these specified including appearance, throw, noise level, adjustability, etc.

3.7 AIR TERMINAL UNIT INSTALLATION

- A. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."
- B. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.
- C. Where installing piping adjacent to air terminal unit, allow space for service and maintenance.
- D. Connect heating coils to supply with shutoff valve, strainer, control valve, and union or flange; and to return with balancing valve and union or flange, or as detailed on Drawings.

3.8 FILTER HOUSING INSTALLATION

- A. Mount filters in airtight galvanized steel housings furnished by the filter manufacturer, or shop-fabricated. Housings shall incorporate integral tracks to accommodate filters, and flanges for connection to duct or casing system.
 - 1. Sealing: Incorporate positive-sealing gasket material on channels to seal top and bottom of filter cartridge frames and to prevent bypass of unfiltered air.
 - 2. Access Doors: Hinged, with continuous gaskets on perimeter and positive-locking latch handle devices.
- B. Air filters shall be accessible for cleaning or replacement.
- C. Identify each filter access door with 1/2 inch high minimum stenciled letters.

3.9 TEMPORARY FILTERS

- A. Provide temporary filters for all fans that are operated during construction; after all construction dirt has been removed from the building install new filters at no additional cost to the Owner. In addition to temporary filters at filter location, provide temporary filters on all duct openings which will operate under a negative pressure.
 - 1. Filters used for temporary operation shall be the same as permanent filters for the application. Filters used for duct openings may be 1 inch thick pleated media disposable type.

3.10 DAMPER INSTALLATION

- A. All dampers automatically controlled by damper motors are specified under "Temperature Control System" except those specified with items of equipment.
- B. Provide opposed blade manual air dampers at each branch duct connection and at locations indicated on the drawings and where necessary to control air flow for balancing system. Provide an opposed blade balancing damper in each zone supply duct. Provide an access panel or Ventlok flush type damper regulator on ceiling or wall for each concealed damper.
- C. Install fusible link fire dampers full size of duct at points where shown or required.
- D. Provide 18 inch x 12 inch minimum hinged access doors in ductwork and furring for easy access to each fire damper; insulated access doors in insulated ducts. Label access doors with 1/2 inch high red letters.
 - 1. Provide Ventlok Series 100, Durodyne, or equal access doors with hardware for convenient access to all automatic dampers and other components of the system, insulated type in insulated ducts. Provide Ventlok #202 for light duty up to 2 inch thick doors, #260 heavy-duty up to 2 inch thick doors and #310 heavy-duty for greater than 2 inch thick doors. Provide #260 hinges on all hinged and personnel access doors; include gasketing.

3.11 DUCTWORK INSTALLATION

- A. Assemble and install ductwork in accordance with recognized industry practices which will achieve air tight and noiseless (no objectionable noise) systems capable of performing each indicated service. Install each run with minimum of joints. Align ductwork accurately at connections within 1/8 inch misalignment tolerance and with internal surfaces smooth. Support ducts rigidly with suitable ties, braces, hangers, and anchors of type which will hold ducts true to shape and to prevent buckling. Where possible, install ductwork to clear construction by 1/4 inch minimum, except at air inlets and outlets. Where ductwork will not clear construction, secure duct firmly to eliminate noise in the system.
- B. Duct Joints: Install duct sealers, pop rivets or sheet metal screws at each fitting and joint. Duct sealer shall be fire retardant. Sheet metal screw for joints shall be minimum #10 size galvanized.
- C. Upper connection of support to wood structure shall be with wood screws or lag screws in shear fastened in the upper one half of the wood structural member. Fasteners shall conform to the following schedule:

For ducts with P/2=30"	#10 x 1-1/2" wood screw
For ducts with P/2=72"	1/4"x 1-1/2" lag screw

For ducts with P/2 over 73"	3/8"x 1-1/2" lag screw
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- D. Upper connection in tension to wood shall not be used unless absolutely necessary. Where deemed necessary the contractor shall submit calculations to show the size fastener and penetration required to support loads in tension from wood in accordance with the following schedule:

For ducts with P/2=30"	260 pounds per hanger
For ducts with P/2=72"	320 pounds per hanger
For ducts with P/2=96"	460 pounds per hanger
For duct with P/2 larger than 120"	NOT ALLOWED

- E. Install concrete inserts for support of ductwork in coordination with formwork as required to avoid delays in work.
- F. Upper connection to manufactured truss construction must comply with truss manufacturers published requirements and Structural Engineers requirements.
- G. Where ducts pass through interior partitions and exterior walls, conceal space between construction opening and duct or duct plus insulation with sheet metal flanges of same gauge as duct. Overlap opening on four sides by at least 1-1/2 inches.
- H. Support ductwork in manner complying with SMACNA "HVAC Duct Construction Standards," hangers and supports sections. Where special hanging of ductwork is detailed or shown on Drawings, Drawings shall be followed. Angles shall be attached to overhead construction in a manner so as to allow a minimum of 2 inches of movement in all directions with no bending or sagging of the angle.
1. Except where modified in individual paragraphs of this Section, provide hanger support with minimum 18 gauge straps, 1 inch wide. Fold duct strap over at bottom of duct.
 2. Install duct supports to rectangular ducts with sheet metal screws. Provide one screw at top of duct and one screw into strap at bottom of duct.
- I. Installation of Flexible Ductwork:
1. Provide flexible ducts with supports at 30 inch centers with 2 inch wide, 26 gauge steel hanger collar attached to the structure with an approved duct hanger. Installation shall minimize sharp radius turns or offsets.
 - a. Supports shall be in accordance with SMACNA HVAC Duct Construction Standards (Metal and Flexible).
 - b. Make bends to maintain R/W-1.5.
 2. Make connections to rigid duct and units with Panduit style draw band at inner liner material, and a second draw band over the outer vapor barrier material.
 3. Make connection to duct with spin-in fittings, with air scoop and balance damper.
- J. Installation of Kitchen Exhaust Ducts (Type 1):
1. Install commercial kitchen hood exhaust ducts without dips and traps that may hold grease.
 2. Slope duct a minimum of 2 percent to drain grease back to the hood.
 3. Provide for thermal expansion of ductwork through 2000 °F temperature range.

4. Install listed grease duct access panel assemblies at each change of direction and at maximum intervals of 12 feet in horizontal ducts, and at every floor for vertical ducts, and as indicated on Drawings. Locate access panel on top or sides of duct. Locate panel so that edge of opening is not less than 1-1/2 inch from all outside edges of the duct or welded seams. For large horizontal ducts, install 20 inch by 20 inch access panel for personnel entry at maximum intervals of 20 feet.
 5. Install listed grease duct access panel assemblies in accordance with the terms of their listings and the manufacturers' instructions. Access panels shall be labeled with the words: "Access Panel – Do Not Obstruct."
 6. Fabricate ducts with continuous welds for grease-tight construction.
 7. Grind welds to provide smooth surface free of burrs, sharp edges and weld splatter. When welding stainless steel with a No. 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to removed discoloration caused by welding.
 8. Cover grease exhaust duct with two layers of 1-1/2 inch thick field-applied grease duct enclosure. Install grease duct enclosure in accordance with manufacturer's instructions and listing requirements.
- K. Installation of Kitchen Exhaust Ducts (Type 2):
1. Install commercial kitchen hood exhaust ducts without dips and traps that may hold grease.
 2. Slope duct a minimum of 1 percent to drain back to the hood or dishwasher connection.
 3. Install duct access panel assemblies at each change of direction and at maximum intervals of 12 feet in horizontal ducts, and at every floor for vertical ducts, and as indicated on Drawings. Locate access panel on top or sides of duct. Locate panel so that edge of opening is not less than 1-1/2 inch from all outside edges of the duct. For large horizontal ducts, install 20 inch by 20 inch access panel for personnel entry at maximum intervals of 20 feet.
 4. Fabricate ducts with continuous welds for water-tight construction.
 5. Grind welds to provide smooth surface free of burrs, sharp edges and weld splatter. When welding stainless steel with a No. 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to removed discoloration caused by welding.
 6. Fabricate ducts for dishwasher exhaust with seams on top of duct, and with minimum joints.
 7. Access panels shall be labeled with the words: "Access Panel – Do Not Obstruct."
- L. Installation of Shower Exhaust Ducts:
1. Slope duct a minimum of 1 percent to drain back to the exhaust grille.
- M. Paint inside of ducts, visible through grille, dull black.
- N. Where ductwork is installed in finished areas of buildings that do not have ceilings, paint ductwork, support hangers, and air inlets and outlets to match adjacent architectural surfaces, or as directed by Architect.

3.12 PUMP INSTALLATION

- A. Install pumps as shown on Drawings.
- B. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories. Manufacturer recommended clearances shall be maintained.
- C. Independently support pumps and piping so that weight of piping is not supported by pumps and weight of pumps is not supported by piping.

3.13 PIPE JOINTS AND CONNECTIONS

- A. General:
 - 1. Cutting: Cut pipe and tubing square, remove rough edges or burrs. Bevel plain ends of steel pipe.
 - 2. Remove scale, slag, dirt and debris from inside and outside of pipe before assembly.
 - 3. Boss or saddle type fittings or mechanically extracted tube joints will not be allowed.

- B. Threaded Pipe: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply thread compound to external pipe threads: Rectorseal No. 5, Permatex No. 1, or equal.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

- C. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for type of water conveyed by pipe. Join flanges with gasket and bolts according to ASME B31.9.

- D. Copper Pipe and Tubing: All joints shall be brazed according to ASME Section IX, Welding and Brazing Qualifications, except pneumatic control piping, and hydronic piping having grooved-end fittings and couplings.

- E. Welded Pipe:
 - 1. Make up with oxyacetylene or electric arc process.
 - 2. All welding shall conform to the American Standard Code for Power Piping ASME B-31.1. When requested by the Architect, furnish certification from an approved testing agency or National Certified Pipe Welding Bureau that the welders performing the work are qualified.
 - 3. All line welds shall be of the single "V" butt type. Welds for flanges shall be of the fillet type.
 - 4. Where the branch is two pipe sizes smaller than the main or smaller, Bonney Weldolets, Threadolets, Nibco, or equal, may be used in lieu of welding tees.

- F. Flexible Connections:
 - 1. Furnish and install Thermo Tech., Inc. F/J/R, Metraflex, or equal, flexible couplings with limiter bolts on piping connections to all equipment mounted on anti-vibration bases, except fan coil units under 2000 cfm, on each connection to each base mounted pump and where shown. Couplings shall be suitable for pressure and type of service.
 - 2. Flexible connections in refrigerant lines; Flexonic, Anaconda or equal, metal hose, full size.
 - 3. Anchor piping securely on the system side of each flexible connection.

3.14 VALVE INSTALLATION

- A. General:
 - 1. Valves shall be full line size unless indicated otherwise on Drawings.
 - 2. Install horizontal valves with valve stem above horizontal, except butterfly valves.
 - 3. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
 - 4. Locate valves for easy access and provide separate support where necessary.
 - 5. Install valves in position to allow full stem movement.
 - 6. Install exposed polished or enameled connections with special care showing no tool marks or exposed threads.

- 7. Butterfly valves conforming to the paragraph "Butterfly Valves" may be used in lieu of gate or globe valves for locations above grade.
 - 8. Ball valves conforming to the paragraph "Ball Valves" may be used in lieu of gate valves for locations above grade for services 2-1/2 inches and smaller.
 - 9. Valves 2-1/2 inches and smaller (except ball valves) in nonferrous water piping systems may be solder joint type with bronze body and trim.
 - 10. Provide gate or globe valves on inlet and outlet of each pump.
- B. Gate Valves:
- 1. Furnish valves in copper lines with adapters to suit valve / line requirements.
 - 2. Underground gate valves:
 - a. Underground valves 3 inches and smaller may be furnished with operating nuts or hand-wheels, and with Ring-Tite joint ends.
 - b. Furnish and deliver to Owner one wrench of each size required for operating underground valves.
- C. Swing Check Valves: Install in horizontal position with hinge pin level.
- D. Butterfly Valves: Install with stems horizontal.
- E. Silent Check Valves: Install in horizontal or vertical position between flanges.
- F. Calibrated Balancing Valves: Install calibrated balancing valves per manufacturers' recommendations, including requirements for straight pipe lengths at valve inlet and outlet.
- G. Air Vent Valves:
- 1. Install with shutoff valves or cocks and drain to floor sink or drain.
 - 2. At each high point of piping provide manual air vent connection at top of pipe. Provide ball valve within 18 inches of ceiling in accessible location, and extend drain line to allow convenient access.
- H. Valve Adjustment: Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.15 DUCTWORK SEALING AND LEAK TESTING

- A. All ductwork shall receive a Class A seal.
- B. Seal airtight all joints and seams, including standing seams and manufactured joints and seams, of all supply, return and exhaust ducts except those exposed in conditioned space.
- C. Leakage Classes:

<u>Pressure Class</u>	<u>Leakage Class</u>	
	<u>Round Duct</u>	<u>Rectangular Duct</u>
2"W.G. or less	8	16
4"W.G. or greater	2	4

- D. All duct systems (supply, return, outside air intake, and exhaust), except those identified on compliance forms on Drawings as requiring Acceptance Testing per the requirements of the California Energy Code, shall be tested in accordance with the requirements of SMACNA's "HVAC Air Duct Leakage Test Manual." Test pressure shall be equal to the pressure class of the duct. For additional duct leak testing requirements, refer to Section 23 00 50, "Basic HVAC Materials and Methods," Article, "Acceptance Requirements."

3.16 HYDRONIC SPECIALTIES INSTALLATION

- A. Install expansion tanks above the air separator. Install tank fitting in tank bottom and charge tank. Use manual vent for initial fill to establish proper water level in tank.
- B. Install tank fittings that are shipped loose.
- C. Support tank from floor or structure above with sufficient strength to carry weight of tank, piping connections, fittings, plus tank full of water. Do not overload building components and structural members.
- D. Install expansion tanks on the floor. Vent and purge air from hydronic system, and ensure that tank is properly charged with air to suit system Project requirements.
- E. Install tangential air separator in pump suction. Install blowdown piping with gate or full-port ball valve; extend full size to nearest floor drain.
- F. Calibrated Balancing Valves: Install calibrated balancing valves per manufacturers' recommendations, including requirements for straight pipe lengths at valve inlet and outlet.
- G. Air Vent Valves:
 - 1. Install with shutoff valves or cocks and drain to floor sink or drain.
 - 2. At each high point of piping, and elsewhere where required for system air venting and drainage, provide manual air vent connection at top of pipe. Provide ball valve within 18 inches of ceiling in accessible location, and extend drain line to allow convenient access.

3.17 AIR HANDLING UNIT INSTALLATION

- A. The air handling units shall be designed within the dimensions and space limitations, as indicated on the drawings and as specified. The unit manufacturer shall take these dimensions and space limitations into consideration for the design required and shall submit dimensional data on the drawings.
- B. Install piping adjacent to air-handling unit to allow service and maintenance.
- C. Connect piping to air-handling units mounted on vibration isolators with flexible connectors.
- D. Connect condensate drain pans at each drain connection (each side of unit for double-slope pans). Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan as detailed on drawings, and install cleanouts at changes in direction.
- E. Hydronic Piping: Comply with applicable requirements in Division 23 Section "Hydronic Piping." Install shutoff valve and union or flange at each coil supply connection. Install balancing valve and union or flange at each coil return connection.
- F. Each individual unit interior and exterior shall be inspected and reviewed by the unit manufacturer's representative, before start-up. The unit manufacturer shall supervise the

installation of final filters, the removal of all component shipping blocks, removal of any and all interior and exterior cleanliness protection, and the removal of any duct covering protection.

- G. Units shall then be started-up by the unit manufacturer in conjunction with the Contractor. Start-up shall include run testing the fan, and confirming the vibration parameters, etc., of the fan assembly, all per submitted test procedures. The unit manufacturer shall submit a written start-up report to the Architect.
- H. The unit manufacturer shall supervise the unit erection. This manufacturer's representative shall perform start-up, checkout and testing of each unit, witness field testing, and instruct the Owner's representatives of the use and maintenance of the individual components and entire unit. These services shall be part of the unit manufacturer's bid and shall be provided at no extra cost.
- I. Training of the Owner's operation and maintenance personnel is required in cooperation with the Owner's Representative. Provide competent, factory authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, and troubleshooting of the installed systems. The instruction shall be scheduled in coordination with the Owner's Representative after submission and approval of formal training plans.
- J. After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems and after completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.18 BOILER INSTALLATION

- A. Equipment Mounting: Install boilers using elastomeric pads elastomeric mounts per Mounting Details. Comply with requirements for vibration isolation devices specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment." Minimum Deflection: 1/4 inch.
- B. Install gas-fired boilers according to NFPA 54.
- C. Assemble and install boiler trim.
- D. Install electrical devices furnished with boiler but not specified to be factory mounted.
- E. Install control wiring to field-mounted electrical devices.
- F. Connect piping to boilers, except safety relief valve connections, with flexible connectors of materials suitable for service.
- G. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas train connection. Provide a reducer if required.
- H. Connect hot-water piping to supply- and return-boiler tappings with shutoff valve and union or flange at each connection.
- I. Install flue venting kit and combustion-air intake.
- J. Perform installation and startup checks according to manufacturer's written instructions.

- K. Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
- L. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain boilers.

3.19 CHILLER INSTALLATION

- A. Examine roughing-in for equipment support, anchor-bolt sizes and locations, piping, and electrical connections to verify actual locations, sizes, and other conditions affecting chiller performance, maintenance, and operations before equipment installation.
- B. Equipment Mounting: Install chiller on concrete bases using elastomeric pads.
- C. Maintain manufacturer's recommended clearances for service and maintenance.
- D. Install piping adjacent to chiller to allow service and maintenance.
- E. Engage a factory-authorized service representative to perform startup service.
- F. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain chillers. Video record the training sessions.

3.20 TEMPERATURE CONTROL SYSTEM INSTALLATION

- A. Provide thermostats where indicated on drawings. All wiring shall be in conduit. Provide all relays, transformers and the like to render the control system complete and fully operable. All control conduit to be rigid steel type.

3.21 EQUIPMENT START-UP

- A. Initial start-up of the systems and pumps shall be under the direct supervision of the Contractor.
- B. Equipment start-up shall not be performed until the piping systems have been flushed and treated and the initial water flow balance has been completed.
- C. It shall be the responsibility of the Contractor to assemble and supervise a start-up team consisting of controls contractor, start-up technician, and test and balance contractor; all to work in concert to assure that the systems are started, balanced, and operate in accordance with the design.
- D. After start-up is complete, instruct the Owner's personnel in the operation and maintenance of the systems. Obtain from the Owner's representative a signed memo certifying that instruction has been received.
- E. For additional requirements, refer to article, Check, Test and Start Requirements, in Section 23 00 50, Basic HVAC Materials and Methods.

3.22 TESTING AND BALANCING

- A. For testing and balancing requirements, refer to Section 23 05 93, Testing and Balancing for HVAC.

3.23 CLEANING AND PROTECTION

- A. As each duct section is installed, clean interior of ductwork of dust and debris. Clean external surfaces of foreign substances that might cause corrosive deterioration of metal or where ductwork is to be painted.
- B. Strip protective paper from stainless steel ductwork surfaces, and repair finish wherever it has been damaged.
- C. Temporary Closure: At ends of ducts that are not connected to equipment or air distribution devices at time of ductwork installation, provide temporary closure of polyethylene film or other covering that will prevent entrance of dust and debris until connections are to be completed.
- D. As each internally lined duct section is installed, check internal lining for small cuts, tears, or abrasions. Repair all damage with fire retardant adhesive.

3.24 EQUIPMENT MOUNTING

- A. Mount and anchor equipment in strict compliance with Drawings details. Alternate anchorage methods will not be considered for roof mounted equipment.

3.25 GROOVED-END FITTINGS AND COUPLINGS SCHEDULE

- A. Optional grooved-end fittings and couplings shall be utilized as follows:
 - 1. Chilled and condenser water piping:
 - a. Mechanical Rooms, where accessible for service or replacement.
 - b. Above lay-in type suspended ceilings, where accessible by ladder.
 - c. Outside building above grade.
 - 2. Heating hot water piping:
 - a. Mechanical Rooms, where accessible for service or replacement.
 - 3. Grooved-end fittings and couplings shall not be installed in vertical building shafts.

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION AND RELATED WORK

A. This section applies to all Division 26 and is part of all other Division 26 sections.

B. Index of Electrical Specifications:

26 00 10	General Provisions
26 00 20	Basic Materials & Methods
26 05 19	Wire & Cable
26 05 26	Grounding
26 05 33	Conduit & Fittings
26 05 36	Cable Tray
26 05 72	Overcurrent Protection
26 05 73	Overcurrent Protective Device Coordination
26 24 00	Electric Service and Distribution
26 24 16	Panelboards
26 27 26	Wiring Devices
26 28 16	Disconnects
26 28 17	Outlet Boxes
26 28 26	Pull & Junction Boxes
26 32 13	Diesel Engine Generator
26 36 00	Automatic Transfer Switch
26 51 00	Lighting Fixtures
27 30 00	Telecommunication Copper Distribution
28 31 11	Fire Alarm System

1.2 SCOPE

A. Provide all labor, materials, equipment and services required for the complete installation, checkout and startup of all systems shown and specified.

B. The general extent of the electrical work is shown on the electrical drawings, mechanical, plumbing, food service, civil, security electronics and architectural drawings, and includes, but is not limited to the following items:

1. Power distribution system, including new main switchboard, distribution switchboards, panels, feeders, ground system and branch circuits including wiring devices.
2. Emergency power distribution system including engine generator set, auto transfer switch, distribution equipment, panels, feeders, ground system and branch circuit wiring including wiring devices
3. Furnishing and installation of lighting fixtures, and associated hardware and finishes to make a complete and operational assemblies.
4. Raceway system cabling, equipment racks, outlets and terminal boards for data, cable television and telephone systems.
5. Connection of all motors, controllers and control equipment for HVAC and plumbing systems and the furnishing and complete installation of all wire, receptacles, conduit, final connections and fittings required therefore. Unless indicated otherwise, all motors required for these systems will be furnished by others.
6. Complete fire alarm system including system design, fire alarm panels, equipment, devices, wiring and connections for a complete and operable system.

7. Motor starters, disconnect switches, installation of starters, connections of motors, and all power and control circuits and wiring for mechanical food service and plumbing equipment.
 8. Trenching, excavation, backfill and compaction as required by work under Division 26.
 9. Branch circuits and outlets for light fixtures.
 10. Cutting, patching, caulking and core boring for all penetrations required for electrical work.
 11. Hangers, supports, anchors, etc., necessary for the electrical work.
 12. As-Built electrical drawings.
 13. Concrete work which is part of the electrical installation.
 14. Site electrical work as indicated on drawings, including site electrical demolition.
 15. All electrical work shown as by Division 26 on mechanical, plumbing and security electronics drawings or in Division 23 and Division 27 specifications is a part of this contract.
 16. Electrical demolition work as indicated on drawings.
- C. Where the work of several crafts is involved, coordinate all related work to provide each system in complete and in proper operating order.
- D. Cooperate with all others involved in the project, with due regard to their work, to promote rapid completion of the entire project.
- E. Local Conditions: The Contractor shall thoroughly familiarize himself with the work as well as the local conditions under which the work is to be performed. Schedule work with regard to seasons, weather, climatic conditions, and all other local conditions which may affect the progress and quality of the work.

1.3 CODES AND STANDARDS

- A. Codes: Perform all work in strict accordance with all applicable national, state and local codes; including but not limited to the latest legally enacted editions of the following specifically noted requirements:
1. California Electric Code – CEC
 2. ANSI-C2, National Electrical Safety Code – NESC
 3. Uniform Building Code – UBC
 4. California Fire Code – CFC
- B. Standards: Reference to the following standards infers that installation, equipment and material shall be within the limits for which it was designed, tested and approved, in conformance with the current publications and standards of the following organizations:
1. American National Standards Institute – ANSI
 2. American Society for Testing and Materials – ASTM
 3. American Society of Heating Refrigerating and Air Conditioning Engineers - ASHRAE (Standard 90-75)
 4. Institute of Electrical and Electronics Engineers- IEEE

5. Insulated Cable Engineers Association – ICEA
 6. National Electrical Contractors Association – NECA
 7. National Electrical Manufacturers' Association – NEMA
 8. National Fire Protection Association - NFPA
 9. Underwriters' Laboratories – UL
- C. Each type of material shall be of the same manufacturer and quality throughout the work.

1.4 SPECIFICATION TERMINOLOGY

- A. Streamlining: In many instances, the products, reference standards, and other itemized specifications have been listed without verbiage. In these cases, it is implied that the Contractor shall provide the products and perform in accordance with the reference listed.
- B. "Provide" means furnish all products, labor, sub-contracts, and appurtenances required and install to a complete and properly operating, finished condition.
- C. "Furnish" means to purchase material as shown and specified, and cart the material to an approved location at the site or elsewhere as noted or agreed, to be installed by supporting crafts.
- D. "Install" means to set in place and connect, ready for use and in complete and properly operating finished condition, material that has been furnished.
- E. "Rough-in and connect" means provide an appropriate system connection such as conduit with junction boxes, wiring, switches, disconnects, etc., and all wiring connections. Equipment furnished is received, uncrated, assembled and set in place under the Division in which it is specified.
- F. "Accessible" means arranged so that an appropriately dressed person, 6'-2" tall, weighing 250 pounds, may approach the area in question with the tools and products necessary for the work intended, and may then position himself to properly and safely perform the task to be accomplished, without disassembly or damage to the surrounding installation.
- G. "Serviceable" means arranged so that the component or product in question may be properly removed, and replaced without disassembly, destruction or damage to the surrounding installation.
- H. "Product" is a generic term which includes materials, equipment, fixtures and any physical item used on the project.

1.5 WORKMANSHIP SUPERVISION

- A. All workmanship shall be first-class and carried out in a manner satisfactory to and approved by the Architect or designated representative.
- B. This Contractor shall personally, or through an authorized and competent representative, constantly supervise the work and so far as possible, keep the same foreman and workmen on the job throughout.

1.6 CONFERENCE WITH OWNER

- A. Confer with the Owners representative to confirm exact locations, mounting heights and arrangements of all finish work prior to roughing in. Minor relocations and rearrangements of the work requested at this time shall be included at no additional cost to the Contract; this includes adjusting outlets to suit equipment connection point requirements, splash back height of counters, etc.

1.7 DRAWINGS, SPECIFICATIONS AND SYMBOLS

- A. The drawings and specifications are complementary; what is shown on one is as binding as if called for in both. Do not scale the drawings. Locations of devices, fixtures and equipment are approximate unless dimensioned. Use Architectural drawings to verify exact locations of doors, partitions and similar features.
- B. The drawings are partly diagrammatic and do not show precise routing of conduits or exact locations of all products, and may not show in minute detail all features of the installation; however provide all systems complete and in proper operating order.
- C. Drawing symbols used for basic materials, equipment and methods are commonly used by the industry and should be universally understood. Special items are identified by a supplementary list of graphical illustrations, or called for on the drawings or in the specifications.
- D. Inspect the site and verify all measurements and conditions and be responsible for the correctness of same.
- E. Any errors or omissions of detail in either the drawings or the specifications shall not relieve the Contractor from correctly installing all materials necessary for complete and operational electrical systems.

1.8 SAFETY AND INDEMNITY

- A. The Contractor shall be responsible for implementing, maintaining and supervising all necessary safety precautions which will ensure against injury to persons or damage to property as a result of any of his work, tools or equipment on or off the project, before, during or after normal work hours. No drawing review, construction review or any other act or service rendered by the Owner, Architect, their employees or consultants shall be construed to approve or judge upon the adequacy of the Contractor's safety measures.

1.9 PRODUCT AND SYSTEM SUBMITTALS

- A. Submittals: Provide submittals for all products in accordance with Division 1, required submittal list to demonstrate compliance with the requirements of the project. Submit data no later than thirty (30) days after award of contract or, in any case, to allow sufficient time for review without delaying construction. Furnish equipment submittals in the manner described elsewhere in these specifications. In addition, include data for review, and organize data, as noted below:
 - 1. Specifications reference and/or drawing reference for which literature is submitted for review with an index, following specifications format, and item by item identification.

2. Manufacturer's name and address, and supplier's name, address and phone number.
 3. Catalog designation or model number.
 4. Rough-in data and dimensions.
 5. Operation characteristics.
 6. Complete customized listing of characteristics required. Indicate whether item is "As Specified" or "Proposed Substitution". Indicate any deviations on submittal. Mark out all non-applicable items. The terminology "As Specified" used without this customized listing is not acceptable.
 7. Wiring diagrams for the specific system.
 8. Coordination data to check protective device.
 9. Working construction drawings (shop drawings).
- B. Submittal Data: Prior to the submission of the required shop drawings, hold a meeting with all of the trades and check the shop drawings for discrepancies, dimensional errors, omissions, contradictions and departures from the contract requirements. The shop drawings shall then be corrected and submitted to the Architect with appropriate notes.
- C. With prior permission from the Engineer, partial submittals will be considered for review provided that they are complete sections, as listed below:
1. Main Switchboard
 2. Distribution Boards
 3. Lighting Fixtures, Lamps Control Equipment and Accessories
 4. Motor Controls and Disconnects
 5. Raceways, Fittings, and Supports
 6. Panels
 7. Wire and Cable
 8. Wiring Devices
 9. Contactors and/or relays
 10. Diesel Generator
 11. Auto Transfer Equipment
 12. Cable Tray
 13. Data Telephone and CATV Cables, Racks and Wiring Devices
 14. Fire Alarm Equipment
- D. Mark submittal literature and shop drawings clearly and bind 8 1/2" x 11" literature in three-hole loose-leaf or spiral bound binders by individual sets or as noted in Division 1.

- E. Submittal review is for general design and arrangement only and does not relieve the Contractor from any of the requirements of the Contract Documents. Submittals will not be checked for quantity, dimension, fit or proper technical design of manufactured equipment. Where deviations of substitute product or system performance have not been specifically noted in the submittal by the Contractor, provision of a complete and satisfactory working installation of equal quality to system specified is the responsibility of the Contractor.

1.10 SUBSTITUTIONS

- A. Material and equipment has been specified to establish a standard of design and quality.
- B. Submit "submittals" on all substituted items in accordance with Division 1 and article above regarding "Submittals".
- C. Only one request for substitution shall be considered on each item of materials or equipment.
- D. Architect reserves the right to require originally specified items.
- E. Acceptance of a substitute is not to be considered a release from the Specifications. Correct any deficiencies in an item, even though approved, at Contractor's expense.
- F. Contractor shall be responsible for installation of approved substitution. He shall make and pay for any changes affected in other trades as a result of a substituted item. No increase in Contract sum shall be allowed.
- G. Failure to comply with any of the above requirements will necessitate that the original specified items be supplied as well as reimburse the Contractor for the dollar amount for loss of scheduled time, trades coordination and work already constructed that may need to be redone or demolished.

1.11 INSPECTION

- A. The Contractor shall cooperate with the Engineer and shall provide assistance at all times for the inspection of the electrical work. Remove covers, operate machinery, or perform any reasonable work which, in the opinion of the Engineer, will be necessary to determine the quality or adequacy of the work.
- B. If any material does not conform with these specifications, within three (3) days after being notified by the Architect, remove the materials from the premises.
- C. Work shall not be closed in or covered before inspection and approval by the Owner. Cost of uncovering and making repairs where uninspected work has been closed in shall be burdened by the Contractor.

1.12 PERMITS AND TESTS

- A. Schedule, obtain, and pay for all permits, fees, and/or services required by local authorities and by these specifications.

- B. Request for Tests: Notify the Owner a minimum of 72 hours in advance of tests. In the event the Owner does not witness the test, certify in writing that all specified tests have been made in accordance with the specifications.
- C. Deficiencies: Immediately correct all deficiencies which are evidenced during the tests and repeat tests until system is approved. Do not cover or conceal electrical installations until satisfactory tests are made and approved.
- D. Operating Tests: Upon request from the Owner or Engineer, place the entire electrical installation and/or any portion thereof, in operation to demonstrate satisfactory operation.

1.13 IDENTIFICATION

- A. Equipment Labels and Nameplates:
 - 1. Provide rigid engraved labels and nameplates of laminated black plastic 1/16-inch thick with white letters on a black background. Label emergency equipment with white letters on red background.
 - a. Securely attach labels with two ovalhead screws, minimum, per label.
 - b. Temporary or pen marking is not permitted on equipment. Repaint trims, housings, etc., where markings cannot be readily removed. Refinish defaced finishes.
 - c. No labeling abbreviations will be permitted without prior approval.
 - 2. Label and Nameplate Locations:
 - a. Provide 1/8" minimum height letters on following equipment:
 - 1) Secondary feeder breakers in distribution equipment. Designation as required by load served.
 - 2) Special equipment housed in cabinets, as designated on plans, on outside of door.
 - 3) Panelboards, switchboards, as designated on plans, on outside of door.
 - 4) Distribution transformers.
 - 5) Disconnects and starters for motors or fixed appliances. (Include item designation and branch feeder number, i.e., FAN #4, MCC-2).
 - 6) Designated electrical equipment.
 - b. Provide 1/8" minimum height, engraved device plates on switches and receptacles to identify source and circuit numbers.
 - c. Provide 1/8" minimum height letters on lighting control relays, dimmer controls and remote lighting control equipment.

- B. Branch Circuit Panelboard Directories: Provide neatly typed schedule (odd numbered circuits on left side even on right side) under plastic jacket or protective cover to protect the schedule from damage or dirt. Securely mount on inside face of panelboard door. Define briefly, but accurately, nature of connected load (i.e., Lighting Room 102, Receptacles, Boiler Room, Etc.) as approved. Sequentially numbered schedules shall not be used.
- C. Empty Conduits: Provide tags with typed description of purpose, and location of opposite end, wired to each end of conduits provided for future equipment.
- D. Conduits: Mark all conduits entering or leaving panelboards with indelible black magic marker with the circuit numbers of the circuits contained inside.
- E. Junction Boxes: Mark the circuit numbers of wiring on all junction boxes with sheet steel covers. Mark with indelible black marker. On exposed junction boxes in public areas, mark on inside of cover.

1.14 RECORD DRAWINGS

- A. In addition to other requirements, mark up a clean set of drawings as the work progresses, to show the dimensioned location and routing of all electrical work which will become permanently concealed. Show routing and location of items cast in concrete or buried underground. Show routing of work in permanently concealed blind spaces within the building. Show complete routing and sizing of any significant revisions to the systems shown.
- B. Maintain "record document" drawings in an up-to-date fashion in conjunction with the actual progress of installation. Accurate progress mark-ups shall be available on-site for examination by the Architect or Electrical Engineer at all times.
- C. Provide record drawings in accordance with Division 1.
- D. Prepare wiring diagrams on reproducible media for all individual special systems as installed. Identify all components and show all wire and terminal numbers and connections.
- E. At completion of project, deliver these drawings to the Architect and obtain written receipt.

1.15 OPERATING INSTRUCTIONS

- A. Prior to final acceptance, instruct an authorized representative of the Owner for sixteen (16) hours on the proper operation and maintenance of all electrical systems and equipment under this contract. This requirement is for several systems, and is in addition to all special training specified in other sections. Make available a qualified technician for each component of the installation for this instruction. Give these operating instructions after the operation and maintenance manuals have been furnished to the Owner. Submit written certification, signed by the Contractor and an authorized representative of the Owner, that this has been completed.

1.16 OPERATION AND MAINTENANCE MANUALS

- A. Provide Operation and Maintenance Manuals in the manner described elsewhere in these specifications. In addition, organize manual and include data and narrative as noted below. Bind each manual in a hard-backed loose-leaf binder.
- B. Provide a separate chapter for each section of the electrical specifications with sub-chapters for each class of equipment or system. Provide a table of contents for each chapter, and each major item in each chapter, to indicate the page number of each. Label all pages to assure correct placement in manual. Identify each piece of equipment with its associated specification description.
- C. Operating Sequence Narrative:
 - 1. In each chapter, describe the procedures necessary for personnel to operate the system and equipment covered in that chapter.
 - 2. Describe procedures for start-up, operation, emergency operation and shutdown of each system. If a particular sequence is required, give step-by-step instructions in that order.
 - 3. Describe all seasonal adjustments which should be accomplished for each system.
 - 4. Provide the above descriptions in typewritten, simple outline, narrative form.
- D. Maintenance Instructions:
 - 1. Provide complete information for preventive maintenance for each product, including recommended frequency of performance for each preventive maintenance task.
 - 2. Provide instructions for minor repair or adjustments required for preventive maintenance.
 - 3. Provide all information of a maintenance nature covering warranty items, etc., which have not been discussed in the manufacturers' literature or the operating sequence narrative.
 - 4. Provide complete information data for all the spare and replacement parts for each product and system. Properly identify each part by part number and manufacturer.
- E. Manufacturer's Brochures: Include manufacturers' descriptive literature covering all products used in each system, together with illustrations, exploded views and renewal parts lists. Highlight all applicable items and instructions, or mark-out non-applicable items.
- F. Shop Drawings: Provide a copy of all corrected, approved shop drawings for the project with the manufacturers' brochures or properly identified in a separate subsection.
- G. Operation and Maintenance Manuals shall be fully corrected to include review comments prior to final submission to the Owner.

1.17 GUARANTEE

- A. The guarantee provision of this specification requires prompt replacement of defective equipment, materials, products, or workmanship that may occur within one year of completion. This includes, but is not limited to, all work required to restore or replace the defective items and to make necessary adjustments to the entire installation as required to provide safe, proper operation.
- B. This guarantee period shall begin on the day the completed installation is released for full use by the Owner, and shall be a date mutually agreeable to the Owner and Contractor. Any item released for use to the Owner prior to full release, shall have its guarantee period start the day that particular item is released for use by the Owner, if the Contractor secures from the Owner written authorization for the guarantee for the particular item or system to begin prior to completion of the project. If written authorization is not obtained, the guarantee shall begin upon the date of full use by the Owner, or as otherwise agreed in writing between the Owner and Contractor.
- C. All extending warranties required to be furnished on specific items by this contract shall be delivered to the Owner prior to completion of the project.

1.18 PROJECT COMPLETION AND DEMONSTRATION

- A. Tests: During final inspection, conduct operating tests for approval. Demonstrate installation to operate satisfactorily in accordance with requirements of Contract Documents. Should any portion of installation fail to meet requirements of Contract Documents, repair or replace items failing to meet requirements until items can be demonstrated to comply. Have instruments available for measuring light intensities, voltage and current values and for the demonstration of continuity, grounds, or open circuit conditions. Furnish personnel to assist in taking measurements and making tests. In the event that systems are not complete and fully operational at the time of final inspection, all costs of any subsequent inspections shall be borne by the CONTRACTOR at no additional cost to the Owner.
- B. Certificate of Completion: Submit at the time of request for final inspection, a complete letter in the following format:

I, _____ (Name), of _____ (Firm), certify that the electrical work is complete in accordance with Contract Plans and Specifications, and authorized change orders (copies of which are attached hereto) and will be ready for final inspection as of _____ (Date). I further certify that the following Specifications requirements have been fulfilled:

- 1. Megger readings performed _____ (Date).
- 2. Operating manuals completed and instruction of operating personnel performed, _____ (Date). _____ (Signed) Owner's Representative.
- 3. Record document drawings up-to-date, accurate and ready to deliver to Architect.

4. Emergency systems tested and fully operational.
5. Fire Alarm System tested and fully operational.
6. Lighting Control System tested and fully operational.
7. Air conditioning systems tested and fully operational.
8. All other tests required by Specifications have been performed.
9. All specified Owner training complete.
10. All systems are fully operational. Project is ready for final inspection.

SIGNED: _____ DATE: _____

TITLE: _____

-END OF SECTION-

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This Section describes specific requirements, products, and methods of execution which are typical throughout the electrical work of this project. Additional requirements for the specific systems may modify these requirements.

1.2 COORDINATION

- A. Layout all the work in advance and avoid conflict with other work in progress. Physical dimensions shall be determined from Architectural and Structural plans. Verify locations for junction boxes, disconnect switches, stub-ups, etc., for connection to equipment furnished by others, or in other Divisions of this work.

1.3 WORKING SPACE

- A. Provide adequate working space around electrical equipment in compliance with Article 110 of the California Electrical Code. In general, provide 36 inches minimum clear work space in front of panelboards and controls.

1.4 SERVICEABILITY OF PRODUCTS

- A. Furnish all products to provide the proper orientation of serviceable components to access space provided.
- B. Coordinate installation of panels, equipment, system components, and other products to allow proper service areas for all items requiring periodic maintenance inspection or replacement.
- C. Replace or relocate all products incorrectly ordered or installed.

1.5 ACCESSIBILITY OF PRODUCTS

- A. Arrange all work to provide access to all serviceable and/or operable products. Layout work to optimize net usable access space within confines of space available. Advise ARCHITECT, in a timely manner, of areas where proper access cannot be maintained. Furnish layout drawings to verify this claim, if requested.
- B. Provide access doors in ceilings, walls, floors, etc., for access to junction boxes, automatic devices, and all serviceable or operable equipment in concealed spaces.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT FURNISHED IN DIVISION 26

- A. All materials furnished and installed in permanent construction shall be new, full-weight, standard in every way, and in first-class condition.
- B. All materials shall conform with the standards of an organization acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of labeled equipment or materials and by whose labeling the

manufacturer indicate compliance with appropriate standards or performance in a specified manner. Only materials designed for the purpose employed shall be used.

- C. Materials shall be identical with apparatus or equipment which has been in successful operation for at least two years. All materials of similar class or service shall be of one manufacturer.
- D. Capacities, sizes, and dimensions given are minimum unless otherwise indicated. All systems, materials and equipment proposed for use on this project shall be subject to review for adequacy and compliance with Contract Documents.

2.2 MATERIALS AND EQUIPMENT FURNISHED IN OTHER DIVISIONS

- A. Controls, including conduit, wiring, and control devices required for the operation of systems furnished in other Divisions shall be provided complete under the Division of the Specifications in which the equipment is specified.
- B. All work on the project that falls under the jurisdiction of the electrical trade shall be performed by Licensed Electricians in conformance with the electrical specifications.
- C. Provide complete power connections to equipment including but not limited to feeders, connections, disconnects and motor running overcurrent protection. Where starters are provided as part of a packaged equipment, overcurrent heaters shall be provided by the ELECTRICAL CONTRACTOR.

PART 3 - EXECUTION

3.1 STORAGE AND HANDLING

- A. All items shall be delivered and stored in original containers, which shall indicate manufacturer's name, the brand, and the identifying number. Items subject to moisture and/or thermal damage shall be stored in a dry, heated place. All items shall be covered and protected against dirt, water, chemical and/or mechanical damage.

3.2 PROTECTION OF MATERIAL AND EQUIPMENT

- A. The CONTRACTOR shall be responsible for any and all materials and equipment to be installed under this contract. The CONTRACTOR shall make good at his own cost any injury or damage which said materials or equipment may sustain from any source or cause whatsoever before final acceptance.

3.3 INSTALLATION

- A. All materials and equipment shall be installed by skilled craftsmen. The norms for execution of the work shall be in conformity with NEC Chapter 3 and the National Electrical Contractors' Association "Standards of Installation", which herewith is made part of these specifications.
- B. Repair all surfaces and furnish all required material and labor to maintain fireproof, airtight and waterproof characteristics of the construction.
- C. Installation of all equipment shall be in accordance with manufacturers' instructions.

3.4 SUPPORT SYSTEMS

- A. Pipe straps and hanger rods shall be fastened to concrete by means of inserts, expansion bolts, or power-driven fasteners, to brickwork by means of expansion bolts and to hollow masonry by means of toggle bolts.
- B. Hanger rods with spring steel fasteners may be used for 1-1/2" EMT and smaller conduits in dry locations.
- C. Cable trays, multi-conduit runs, etc., shall be supported by double rods at each point of support and be supported independently of any other building system unless noted otherwise on drawings.
- D. Provide sway bracing for suspended light fixtures and conduit supports per local seismic requirements.

3.5 MOUNTING HEIGHTS

- A. Mounting height shall be to center of box above finished floor (AFF) as noted below unless otherwise shown or indicated. Other mounting heights are indicated on the drawings by detail. Specific dimensions AFF are shown adjacent to the symbol. Where devices are shown on architectural elevations, the elevation height shall govern.

Lighting switches and dimmers	46 inches
Convenience outlets and similar devices	18 inches
Convenience outlets in mechanical, boiler rooms and workrooms	48 inches
Motor controllers	60 inches to top
Panelboards	76 inches to top
Telephone panels	72 inches to top
Bracket lights	84 inches
Exterior WP convenience outlets	24 inches AFF
Telephone/data outlets	18 inches
Public telephone outlets	46 inches
Door bell push buttons	46 inches
All bells, chimes, clocks and similar signal devices	90 inches

3.6 CUTTING AND PATCHING

- A. Obtain written permission of the ARCHITECT before cutting or piercing structural members.
- B. Sleeves through floors and walls to be black iron pipe, or galvanized rigid steel, flush with walls, ceilings or finished floors, sized to accommodate the raceway. Grout all penetrations through concrete walls or floors. Holes through existing concrete shall be core drilled.

3.7 PROTECTIVE FINISHES

- A. Take care not to scratch or deface factory finish of electrical apparatus and devices. Repaint all marred or scratched surfaces.
- B. Provide hot dip galvanized components for ferrous materials exposed to the weather.

3.8 TESTING

- A. Prior to final test, all switches, panelboards, devices, and fixtures shall be in place.
- B. Test all electrical systems. They shall be free from short circuits and unintentional grounds. Provide meggar testing for all feeders.
- C. Make all changes necessary to balance the actual electrical loads on the complete system. Arrange for balanced conditions of circuits under connected load demands, as contemplated by the normal working conditions. Final load and balance test reports shall be provided prior to final inspections and project close out.
- D. Conduct a performance test of the ground fault system in accordance with NEC Article 230-95(c) and the requirements of the local agency having jurisdiction.
- E. Furnish one (1) copy of certified test results to the ARCHITECT prior to final inspection.

3.9 CLEAN-UP AND COMMISSIONING

- A. Throughout the work, the CONTRACTOR shall keep the work area reasonably neat and orderly by periodic clean-ups.
- B. As independent parts of the installation are completed, they may be commissioned and utilized during construction.

3.10 WARRANTY

- A. Unless otherwise specified, the warranty starts on the date written notice is given that the project is complete and all required corrections have been made. Warranty shall certify that all defects in materials or workmanship shall be promptly repaired or replaced by the CONTRACTOR, to the satisfaction of the Owner, for a period of one (1) year, except when in the opinion of the ARCHITECT such failure is due to neglect or carelessness by the Owner.

-END OF SECTION-

PART 1 - GENERAL

1.1 RELATED WORK ELSEWHERE

- A. Section 26 05 33: Conduit and Fittings
- B. Section 26 05 26: Grounding

1.2 QUALITY ASSURANCE

- A. All wire and cable shall comply with applicable standards of the Underwriters Laboratories, Inc.
- B. Certify to the Engineer that all terminations made where a crimping tool is required, have been made using a crimping tool approved by the lug manufacturer.

1.3 PRODUCT DELIVER, STORAGE, AND HANDLING

- A. Deliver materials and equipment to project site in manufacturer's original packaging with labeling showing product name, brand, model, project name, address, and Contractor's name. Store in a location as agreeable with Owner, secure from weather or accidental damage.

PART 2 -PRODUCTS

2.1 LABELING

- A. Electrical conductors for power shall be delivered to the job site plainly marked or tagged on 24" centers as follows:
 - 1. Underwriters Label
 - 2. Gauge
 - 3. Voltage
 - 4. Kind of Insulation
 - 5. Name of Manufacturer
 - 6. Trade Name
- B. Conductor labels shall be white PVC tubing with machine printed black marking. Tubing shall be sized to fit conductor insulation. Adhesive strips are not acceptable.

2.2 INSULATION

- A. All conductors #10 and smaller shall be 600 volt, type THWN, or THHN except as noted otherwise.
- B. All conductors #8 and larger shall be 600 volt, type THWN, XHHW, or THHN except as noted otherwise.

- C. All circuit conductors installed within fluorescent fixture raceways shall be 600 volt, 105 degree type, RHH, or THHN except in fixtures that have wiring raceways specifically approved for 75 degree Centigrade wire.

2.3 CONDUCTORS

- A. Unless specifically noted otherwise herein, all conductors for general wiring shall be a minimum of 98% conductivity, stranded, soft drawn copper.
- B. All conductors for control wiring shall be stranded copper only.
- C. Except where noted on the plans or in this specification, the minimum conductor size shall be #12.
- D. Armored cable (Type AC or MC Cable), a fabricated assembly of insulated conductors in a flexible metallic enclosure, is not permissible for use on this project, except for lighting fixture whips.
- E. Nonmetallic-Sheathed Cable (Type NM and NMC), a factory assembly of two or more insulated conductors having an outer sheath moisture resistant, flame retardant, non-metallic material, is not permissible for use on this project.
- F. All conductors shall have identical color insulation from circuit breaker or control panel to load or device.

2.4 PULLING LUBRICANT

- A. Wire pulling lubricant shall be UL or Factory Mutual approved wire pulling compound.

2.5 CONNECTIONS

- A. Wire nuts for joints, splices and taps for conductors #8 and smaller shall consist of a cone shaped expandable coil spring insert, insulated with a teflon or plastic shell. Threaded or crimp types will not be accepted. Use "Skotchlock", "Hydent", or equal.
- B. Terminals for stranded conductors #8 and smaller shall be a pre-insulated crimp type.
- C. Lugs and connectors for conductors #6 and larger shall be compression types of one piece tubular construction with flat rectangular tongues. Two hole lugs shall be used for sizes 4/0 and larger. Fittings for copper conductors shall be tin-plated copper. Fittings for aluminum conductors shall be tin-plated aluminum, factory filled with a corrosion inhibiting and oxide penetrating compound.
- D. Electrical tape shall be UL approved plastic.

2.6 GROUNDING WIRE

- A. #12 AWG minimum, tinned, stranded copper conductor with green color insulation.
- B. Isolated ground conductors shall be #12 AWG minimum tinned, stranded copper with green color insulation and yellow tracer.

PART 3 -EXECUTION

3.1 CLEANING

- A. All debris and moisture shall be removed from raceways, boxes, and cabinets before installing wire or cable.
- B. PULLING
- C. No oil, grease or similar substances shall be used to facilitate the pulling in of conductors. Use a specifically approved anti-static wire pulling compound.
- D. No wire or cable shall be pulled in until all construction which might damage insulation or fill conduit with foreign material is completed.
- E. Wire shall be pulled into conduits with care to prevent damage to insulation. Use basket pulling grips to avoid slipping of insulation on conductors. Nylon rope or other "soft" surfaced cable must be used for pulling in conduits other than steel.
- F. Provide a mandrel pull in all switchboard and panelboard feeder conduits prior to installing conductors.

3.2 CONNECTIONS

- A. Stranded conductors #8 and smaller shall be terminated with terminals of appropriate size where connected to screw type lugs.
- B. Joints, splices and taps in dry locations for conductors #8 and smaller shall be made with twist-on connectors suitably sized for the number and gauge of the conductors.
- C. Furnish and install proper lugs in all panelboards, switchboards and gutters as required to properly terminate every cable. Where paralleled conductors or conductors of large size are to terminate on a breaker, a short length of copper cable (of capacity of the breaker) shall be connected to the breaker, and the proper compression type lug installed to connect this cable to the feeder cable. The cutting of cable strands to fit the breaker will not be permitted.
- D. Connections of copper to aluminum bus bars and lugs shall be made using Belleville washers and flat washers to compensate for differing rates of thermal expansion.
- E. Only crimping tools approved by the manufacturer of the terminals or lugs shall be used.
- F. Uninsulated lugs and wire ends shall be insulated with layers of plastic tape equal to insulation of wire and switchboards, with all irregular surfaces properly padded with insulating putty prior to application of tape. Wire in panels, cabinets, pullboxes and wiring gutters shall be neatly grouped together and laced with #12 standard lacing twine, or cable ties.
- G. In underground locations, joints, splices and taps shall be insulated by the "Skotchcast" epoxy-resin method.

3.3 COLOR CODING AND LABELING

- A. All wiring shall be color coded as follows:

120/208V

Phase A:	Black
Phase B:	Red
Phase C:	Blue
Neutral:	White
Ground:	Green

- B. In addition to color coding, all power, control and alarm wiring shall be numbered and identified by means of wire markers at all switchboards, panelboards, auxiliary gutters, junction boxes, pullboxes, receptacle outlets, light outlets, disconnect switches, and circuit breakers. These markers shall correspond to numbers on shop drawings.

3.4 FIELD QUALITY CONTROL

- A. Operating Test: After installation has been completed, Contractor shall conduct an operating test. The equipment shall be demonstrated to operate in accordance with the requirements of this section of the specifications. Contractor shall furnish necessary instruments and personnel required for test.

-END OF SECTION-

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section describes general requirements, products and methods of execution relating to the furnishing and installation of a grounding system complete as required for this project.

1.2 MINIMUM REQUIREMENTS

- A. The minimum requirement for the system shall conform to Article 250 of the CEC.

1.3 SPECIAL REQUIREMENTS

- A. Unless specified elsewhere, the ohmic values for grounds and grounding systems shall be as follows:
 - 1. For grounding metal enclosures and frames for electrical and electronically operated equipment--5 ohms maximum.
 - 2. For grounding systems which electrical utilization equipment and appliances are connected--5 ohms maximum.
 - 3. For grounding secondary distribution systems, neutrals, non-current carrying metal parts associated with distribution systems, and enclosures of electrical equipment not normally within reach of other than authorized and qualified electrical operating and maintenance personnel--10 ohms maximum.

PART 2 -PRODUCTS

- 2.1** All grounding conductors, ground rods, and equipment required for ground systems shall be in accordance with UL 467 and as follows:

- A. Grounding conductor for building service ground to be bare copper sized in accordance with CEC Article 250.
- B. Grounding conductor for telephone service entrance and panels to be #6 bare copper, with 6'-0" slack cable at each panel.
- C. Grounding conductor for security electronics equipment locations shall be #6 bare copper with 6'-0" slack cable at each location.

2.2 CONNECTIONS

- A. Joints in grounding conductors and mats below grades shall be made with solderless compression connections or with AMPACT TAP equipment. Terminations above grade shall be made with solderless lugs, securely bolted in place.

PART 3 -EXECUTION

3.1 SERVICE GROUND

- A. Create an equipotential plane for the grounding system for this project at the service entrance equipment by connecting the following to the service entrance ground bus:
 - 1. The commercial system's grounded neutral conductor for transformer neutrals.
 - 2. All metallic water services to the building.
 - 3. All "man-made" grounds specified to be installed.
 - 4. The service entrance equipment and all conduits entering and leaving the equipment.
 - 5. The metallic gas mains entering the building past the gas meter, if gas service is installed.
 - 6. Reinforcing steel in slab and/or footings.
 - 7. Structural steel columns (one, minimum).
 - 8. Other items or equipment called for on the drawings.
- B. Current carrying capacity of the grounding and bonding conductors shall be in conformity with table 250-94 of the CEC.

3.2 "MAN-MADE" GROUND

- A. "Man-made" ground shall consist of a "Ufer Ground" as shown on the plans. The "man-made" ground shall be tested with an approved measuring device, such as "Vibroground", in order to verify that resistance does not exceed the specified level.
- B. Furnish certified test results.

3.3 EQUIPMENT GROUND

- A. The raceway system shall be bonded in conformity with CEC requirements to provide a continuous ground path. Where required by code or where called for on the plans, an additional grounding conductor shall be sized in conformity with table 250-95 of the CEC.
- B. Provide separate grounding conductor securely bonded and effectively grounded to both ends of all conduits.

-END OF SECTION-

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This Section describes specific requirements, product, and methods of execution relating to conduit and conduit fittings approved for use on this project. Type, size and installation methods shall be as shown on drawings, required by code and specified in the following.

1.2 QUALITY ASSURANCE

- A. Conduit and conduit fittings shall be standard types and sizes as manufactured by a nationally recognized manufacturer of this type of materials and be in conformity with applicable standards and UL listings.

PART 2 - PRODUCTS

2.1 CONDUIT

- A. Conduit types approved for use on this project shall be of the following types:
 1. Galvanized rigid steel conduit - GRC
 2. Intermediate metal conduit - IMC
 3. Rigid copper-free aluminum conduit
 4. Electrical metallic tubing – EMT
 5. Schedule 40, polyvinyl chloride conduit – PVC
 6. Flexible metallic conduit
 7. Liquid-tight flexible non-metallic conduit – LT

2.2 FITTINGS

- A. Fittings utilized with rigid steel and aluminum shall be galvanized steel or iron or copper-free aluminum weatherproof threaded type. Conduit bushings shall be of the insulated types. Where grounding bushings are required, insulated grounding bushings with pressure type lugs shall be provided.
- B. Couplings and connectors for EMT shall be made of galvanized steel or malleable iron. All connectors shall have insulated throats.
- C. Fittings for PVC 40 shall be polyvinyl chloride, installed using PVC solvent to form a watertight joint, except elbows shall be galvanized rigid steel.
- D. Fittings for flexible metal conduit shall be steel only.
- E. Fittings for liquid-tight flexible conduit shall be steel, of a type incorporating a threaded grounding cone, nylon or plastic compression ring, and a tightening gland, providing a low resistance ground connection. All throats shall be insulated.
- F. Provide compression type fitting for all conduit. Set screw type fittings will NOT be allowed.

2.3 SURFACE MOUNTED METALLIC RACEWAYS:

- A. Steel with grounded receptacles, complete with outlets on centered spacings as called for on the drawings. Raceway shall be grounded and UL listed.
- B. Acceptable manufacturers: Wiremold Co., Walkerdect, or Panduit.
- C. Plugmold shall be single cell two piece metallic raceway. Wiremold 3000 series or equal or as noted on plans. Provide grounded duplex receptacles spaced as noted on plans.

2.4 CONDUIT SUPPORTS:

- A. Pipe hangers for individual conduits shall be factory made, consisting of a pipe ring and threaded suspension rod. The pipe ring shall be springable wrought steel. Rings shall be bolted to or interlocked with the suspension rod socket.
- B. Pipe racks for groups or parallel conduits shall be constructed of galvanized structural steel preformed channels of length as required, suspended on threaded rods and secured thereto with nuts above and below the cross bar.
- C. Factory made pipe straps shall be two-hole galvanized clamps.

2.5 OUTLET BOXES:

- A. Outlet boxes shall be galvanized steel type.
- B. Outlet boxes for surface raceways exposed in public areas shall be Wiremold or equal. Paint to match adjacent surfaces.

2.6 PULL BOXES AND CABINETS:

- A. All pull boxes and cabinets shall be code gauge galvanized steel.

2.7 CONDUIT SEALS:

- A. Conduit seals shall be a fire retardant silicone foam formed in place by the mixing of two liquid components. Comply with ASTM E-119 and Underwriters' Laboratories, Inc.
- B. Manufacturers as follows; or equal:
 - 1. Dow Corning 3-6548 RTV
 - 2. Chase Technology Corp. - CTC PR-855
 - 3. 3M CP 25 Caulk or 3M 303 Putty

PART 3 - EXECUTION

3.1 USES PERMITTED:

- A. Conduits shall be of the size shown on the drawings or as required by the CEC, whichever is larger. Minimum size of conduit above grade shall be 3/4-inch

except for lighting fixture whips. Minimum size for underground conduits shall be 1 inch. Base sizes on using Type THW wire for wires size #6 AWG and larger. Basis type may be THWN for size #8 AWG and smaller. Conduits installed in the following locations shall be of the types specifically identified only:

1. Underground or encased in concrete - Pabco wrapped or PVC coated rigid steel or PVC-40.
2. Outdoors above-ground or damp locations - rigid steel, or IMC.
3. Dry indoor locations, concealed - rigid steel, rigid aluminum, EMT or flexible conduit, IMC.
4. Dry indoor locations exposed – rigid steel only.
5. Motor, transformers and vibrating equipment flexible connections - liquid-tight flexible conduit, minimum 3 feet, maximum 6 feet conduit length.

3.2 INSTALLATION METHODS

- A. All conduit and tubing shall be cut square and reamed smooth at the ends and all joints made tight. Conduit threads shall be lubricated with an approved thread lubricant.
- B. Exposed raceways shall be run parallel to or perpendicular to building lines and bent symmetrically or made up with standard elbows or fittings. Concealed raceways shall be routed as directly as possible with a minimum of bends. Exposed raceways in public areas shall be Wiremold or equal, painted to match adjacent surfaces.
- C. Liquid-tight flexible conduit with supplemental ground jumper shall be used for all motor connections. The ground jumper in flexible conduits shall be within the conduit.
- D. Each conduit shall enter and be securely connected to a cabinet, junction box, pull box or outlet box by means of a locknut on the outside and a locknut and bushing on the inside, or by means of a liquid-tight, threaded, self-locking, cold-weld type wedge adapter. In EMT or flexible metal conduit, the one locknut shall be made wrenchtight. All locknuts shall be the bonding type with sharp edges and shall be installed in a manner that will assure a locking installation. Locknuts and bushings or self-locking adapters will not be required where conduit are screwed into threaded connections. All runs of conduit shall be protected from the entrance of foreign material prior to the installation of conductors.
- E. Conduit or tubing deformed or crushed in any way shall not be installed. Conduit shall be bent only with approved bender (hydraulic or hickey). Bending machines shall be used to make field bends in conduit of 1-1/4" size and larger. Torches shall not be used in making conduit bends.
- F. Raceways shall be run at least 5" from parallel runs of heating system pipes, flues, or other high temperature piping systems.
- G. Pull wires shall be left in all spare and unused conduits. (Nylon "jet-line" or equal).

- H. All conduit stubbed up out of floor and termination inside of an enclosure shall have insulating grounding bushings installed.
- I. Raceways penetrating vapor barriers or traversing from warm to cold areas shall be sealed with a non-hardening duct sealing compound to prevent the accumulation of moisture.
- J. Raceways shall be provided with expansion joints where necessary to allow for thermal expansion and contraction.
- K. The entire electrical raceway system shall form a continuous metallic electrical conductor from service point to every outlet and shall be grounded by connection to the main service ground.
- L. Rigid Steel conduit shall have threads filled with conductive sealant before screwing into fittings.
- M. A ground wire shall be installed in all PVC and flexible conduit, as required by code.
- N. Secure conduit with straps or hangers manufactured for the purpose. Do not notch structural members for the passage of raceways. All conduit shall be securely fastened to the building structure.
- O. If conduit runs penetrate a fire wall, then rigid steel conduit shall be used for a Minimum of 3 feet on each side of the fire wall penetration.

-END OF SECTION-

PART 1 - GENERAL

1.1 SCOPE

- A. This specification covers a Ladder Type Cable Tray System used to route low voltage and/or communication cable distribution for commercial, institutional, industrial and utility needs. The cable tray system shall consist of cable tray and appropriate fittings to complete installation per electrical drawings.

1.2 CLASSIFICATION AND USE

- A. Aluminum cable tray is to be utilized in locations only as covered in Article 392 of the California Electrical Code, as adopted by the National Fire Protection Association and as approved by the American National Standards Institute. Ladder Cable Tray Systems shall be classified by Underwriters Laboratories Inc. and cUL listed under file No. E140705 Guide CYNW, for use in the U.S.

1.3 DESIGN REQUIREMENTS

- A. Maximum Deflection Between Supports: L/240.

1.4 SUBMITTALS

- A. Comply with requirements of Division 1 – Submittal Procedures.
- B. Product Data: Submit manufacturer's product data, including UL classification.
- C. Shop Drawings: Submit shop drawings indicating materials, finish, dimensions, and accessories. Show layout, support and installation details.
- D. Manufacturer Qualifications: Submit manufacturer's certification indicating ISO 9002 quality certified.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer and materials.
- B. Storage: Store materials in a dry area indoors, protected from damage, and in accordance with manufacturer's instructions.
- C. Handling: Protect materials and finishes during handling and installation to prevent damage.

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. The cable tray system specified herein shall be the SpecMate Aluminum L Series Ladder Tray System as manufactured by The Wiremold Company. Systems of other manufacturers may be considered equal if, in the opinion, and with the written approval of the engineer, they meet all the performance standards specified herein.
- B. Acceptable Manufactures:

1. Wiremold Company
2. Thomas & Betts
3. Cablofil
4. PW Industries

2.2 MATERIALS

- A. The tray shall be constructed of 6063 T6 aluminum alloy.
1. The cable tray shall be constructed to form an open and accessible compartment to hold the necessary cables. The tray shall be constructed with two components, (1) two longitudinal support rails (side rails) and (2) the rungs. The rail is a single aluminum extrusion with extending flanges that provide rung support.
 2. The rungs shall have a 7/8" [22.3mm] cable laying surface and be attached with sheet metal screws to the two side rails on 6" centers, creating a cable laying area between the rails.
 3. Cable tray dimensions shall be 12 inches wide and 6 inches deep. No exceptions.
 4. A full complement of fittings for the cable tray shall be provided per plans including, but not limited to , 45 and 90 degree flat elbows, vertical inside and outside elbows, tee fittings, couplings for joining sections of the tray, hangers, end blanks, and all other components necessary to make the system workable. The fittings and accessories shall be of compatible material.

2.3 ACCESSORIES

- A. Grounding: Provide grounding lugs for attachment of continuous ground conductor to tray for entire length of cable tray system. Bond ground conductor to building ground in accordance with CEC requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive cable tray system. Notify the Engineer of conditions that would adversely affect the installation or subsequent utilization of the system. Do not proceed with installation until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Prior to and during installation, refer to the system layout or approval drawings containing all elements of the system. Installer shall comply with complete system instruction sheets.

1. All enclosures shall be mechanically continuous and connected to all electrical boxes and cabinets also in accordance with manufacturer's installation instructions.
 2. All connections shall be checked to make sure they are correctly tightened and to ensure that all enclosures are electrically continuous and bonded with adjacent systems in accordance with the California Electrical Code for proper grounding.
 3. All systems shall be installed complete. Work shall include fastening all enclosures to adjacent wiring systems to install a complete system as indicated on the electrical and/or communication drawings and in the applicable specifications.
- B. Install cable tray system at locations indicated on the drawings and in accordance with manufacturer's instructions.
- C. Load Span Criteria: Install and support cable management system in accordance with span load criteria of L/240.
- D. Cutting:
1. Cut tray in accordance with manufacturer's instructions.
- E. Install cable management system using hardware, splice connectors, support components and accessories furnished by manufacturer
- F. Provide fire stop pillows to maintain fire wall ratings where cable tray penetrates a fire rated wall. Install pillows after installation of cables.

-END OF SECTION-

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section describes general requirements, products, and methods of execution relating to overcurrent protective devices approved for use on this project. Type, duty rating and characteristics, fault interrupting capability and coordination requirements shall be determined from the plans and the following specifications.

1.2 QUALITY ASSURANCE

- A. Devices shall be the latest approved design as manufactured by a nationally recognized manufacturer and in conformity with applicable standards and UL listings.

PART 2 - PRODUCTS

2.1 MOLDED CASE CIRCUIT BREAKERS

- A. Molded case circuit breakers shall be suitable for individual as well as panelboard mounting. Bolt-on type, unless specifically allowed. No breakers designated "plug-on" type allowed.
- B. The breakers shall meet current NEMA and UL specifications as applicable to frame size, standard rating and interrupting capability.
- C. The breakers shall be one-, two-, or three-pole as scheduled, operate manually for normal ON-OFF switching and automatically under overload and short circuit conditions.
- D. Operating handle shall open and close all poles simultaneously on a multi-pole breaker. Operating mechanism shall be trip-free so that contacts cannot be held closed against abnormal overcurrent or short circuit condition.

2.2 FUSIBLE SWITCHES

- A. Fusible switches shall be designed for individual mounting as specified in Section 26 28 16 - DISCONNECTS, or for panelboard mounting.
- B. Switches designed for panelboard mounting shall have the same properties as specified for the individually mounted switches.
- C. Switches shall conform to NEMA and UL 67 standards.
- D. Switches shall be used in conjunction with fuses as specified in the following in order to constitute a complete "Overcurrent Protective Device".

2.3 FUSES

- A. Fuses of the sizes and types specified on the drawings or as required by equipment manufacturers shall be installed. Fuses shall be capable of interrupting the prospective symmetrical fault current. Furnish one complete set of spare fuses of each rating installed to the Owner. Provide fuse puller(s) for fuse sizes used.

2.4 RATINGS

- A. Size devices as shown and specified, or as required by the load being served.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. All Contract Documents apply to this Section.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes computer-based, fault-current and overcurrent protective device coordination studies to be provided by the contractor. Protective devices shall be set based on results of the protective device coordination study.
 - 1. Series-rated devices are not permitted.

1.3 SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.
- C. Qualification Data: For coordination-study specialist.
- D. Other Action Submittals: The following submittals shall be made after the approval process for system protective devices has been completed.
 - 1. Coordination-study input data, including completed computer program input data sheets.
 - 2. Study and Equipment Evaluation Reports.
 - 3. Coordination-Study Report.
- E. QUALITY ASSURANCE
- F. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.
- G. Coordination-Study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
 - 1. Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of the State.
- H. Comply with IEEE 242 for short-circuit currents and coordination time intervals.
- I. Comply with IEEE 399 for general study procedures.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

- A. See Editing Instruction No. 1 in the Evaluations for cautions about naming computer software developers and products. Retain one of three paragraphs and list of computer software developers in this Article. See Division 1 Section "Product Requirements."
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:
 - 1. CGI CYME.
 - 2. EDSA Micro Corporation.
 - 3. ESA Inc.
 - 4. Operation Technology, Inc.
 - 5. SKM Systems Analysis, Inc.

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

- A. Comply with IEEE 399.
- B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.
 - 1. Optional Features:
 - a. Arcing faults.
 - b. Simultaneous faults.
 - c. Explicit negative sequence.
 - d. Mutual coupling in zero sequence.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated.

3.2 POWER SYSTEM DATA

- A. Verify that power system data is indicated on Drawings, allowing Contractor to complete the data gathering specified in this Article. Drawing Coordination Checklist may be useful in verification.

- B. Gather and tabulate the following input data to support coordination study:
 - 1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
 - 2. Impedance of utility service entrance.
 - 3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:
 - a. Circuit-breaker and fuse-current ratings and types.
 - b. Relays and associated power and current transformer ratings and ratios.
 - c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
 - d. Generator kilovolt amperes, size, voltage, and source impedance.
 - e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
 - f. Busway ampacity and impedance.
 - g. Motor horsepower and code letter designation according to NEMA MG 1.
 - 4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:
 - a. Special load considerations, including starting inrush currents and frequent starting and stopping.
 - b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
 - c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
 - d. Generator thermal-damage curve.
 - e. Ratings, types, and settings of utility company's overcurrent protective devices.
 - f. Special overcurrent protective device settings or types stipulated by utility company.

- g. Time-current-characteristic curves of devices specified to be coordinated.
- h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
- i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio overcurrent relays.
- j. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

3.3 FAULT-CURRENT STUDY

- A. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following: Switchgear and switchboard bus.
 - 1. Medium-voltage controller.
 - 2. Motor-control center.
 - 3. Distribution panelboard.
 - 4. Branch circuit panelboard.
- B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.
- C. Calculate momentary and interrupting duties on the basis of maximum available fault current.
- D. See Editing Instruction No. 4 in the Evaluations for discussion of standards listed in first paragraph below.
- E. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 241 and IEEE 242.
 - 1. Transformers:
 - a. ANSI C57.12.10.
 - b. ANSI C57.12.22.
 - c. ANSI C57.12.40.
 - d. IEEE C57.12.00.
 - e. IEEE C57.96.

2. Medium-Voltage Circuit Breakers: IEEE C37.010.
 3. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
 4. Low-Voltage Fuses: IEEE C37.46.
- F. Study Report:
1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.
 2. Retain subparagraph below only for medium- and high-voltage circuit breakers under certain circumstances described in IEEE 399.
 3. Show interrupting (5-cycle) and time-delayed currents (6 cycles and above) on medium-voltage breakers as needed to set relays and assess the sensitivity of overcurrent relays.
- G. Equipment Evaluation Report:
1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
 2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
 3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

3.4 COORDINATION STUDY

- A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.
1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.
 2. Calculate the maximum and minimum interrupting duty (5 cycles to 2 seconds) short-circuit currents.
 3. Calculate the maximum and minimum ground-fault currents.
- B. Comply with IEEE 242 recommendations for fault currents and time intervals.
- C. Transformer Primary Overcurrent Protective Devices:
1. Device shall not operate in response to the following:
 - a. Inrush current when first energized.
 - b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
 - c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.

2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.
- D. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.
- E. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:
 1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
 - a. Device tag.
 - b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
 - c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
 - d. Fuse-current rating and type.
 - e. Ground-fault relay-pickup and time-delay settings.
 2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
 - a. Device tag.
 - b. Voltage and current ratio for curves.
 - c. Three-phase and single-phase damage points for each transformer.
 - d. No damage, melting, and clearing curves for fuses.
 - e. Cable damage curves.
 - f. Transformer inrush points.
 - g. Maximum fault-current cutoff point.
- F. Completed data sheets for setting of overcurrent protective devices.

-END OF SECTION-

PART 1 - GENERAL

1.1 GENERAL

- A. Applicable portions of other Sections within Division 26 are a part of this Section except as supplemented or modified by this Section.
- B. Furnish and install electrical service and distribution system as shown and specified.

1.2 WORK NOT INCLUDED IN THIS SECTION

- A. Utility company service transformer.
- B. That conduit or conductors furnished by the Utility company.

1.3 SUBMITTALS

- A. Submit drawings of switchboard showing metering facilities to utility power company and obtain their approval before submitting to the Engineer.

1.4 SERVICE AND DISTRIBUTION SYSTEM

- A. Furnish and install an electrical distribution system from existing power company utilities consisting of conduit, wire, trenching, backfill, pull boxes, vaults, work related to structures and substructures; and appurtenances as shown on plans specified hereunder and as required by P.G.&E.
- B. Secondary distribution system to the facility will be 120/208V 3-phase, 4 wire, grounded neutral as indicated on Drawings.
- C. Main primary service and transformer pads and bank shall be as determined by the power P.G.&E.
- D. Secondary service shall consist of conduits from transformer secondaries to service entrance equipment wire shall be provided by P.G.&E. Furnish and install ground electrode and grounding busses as directed by power company, and as required by CEC. Closely coordinate with power utility company.
- E. Provide all metering facilities as required by P.G.&E. Contact local power company to determine exact requirements and include all equipment and installation in bid, including facilities for remote metering if required.

PART 2 - PRODUCTS

2.1 SWITCHBOARDS

- A. Switchboards shall be dead front type, completely metal enclosed, self-supporting structure, independent of wall supports of the required number of vertical sections bolted together to form rigid boards 90-3/8-inch high incorporating switching and protective devices of the number, rating and type noted herein or shown on the Drawings with the necessary interconnections, instrumentation and control wiring.

Construction shall be of the universal frame type using die-formed, welded and bolted members. All plates shall be fabricated from code gauge steel.

- B. The bus shall be tinned aluminum of sufficient size based on 1,000 amperes per square inch to limit temperature rise to 55 degrees Celsius and adequately brace supported to withstand mechanical force exerted during short circuit conditions when directly connected to power source having the indicated short circuit current. All connections shall be tightly bolted.
- C. Current transformers and metering will be furnished by P.G.&E. Provide bussing for connection of transformers on both line and load sides. Drill bussing, as required, for current transformer connections. All equipment shall be installed by the switchboard manufacturer.
- D. Make provisions for the installation of P.G.&E.'s metering equipment and entrance conductors, all in strict conformance with the requirements of P.G.&E. and as shown on the Drawings. Switchboard manufacturer shall be held to have submitted shop drawings of the switchboard entrance and metering provisions to the P.G.&E. prior to manufacture. Engineer's shop drawing approval does not imply conformance with P.G.&E. requirements. Provide for remote metering if required by the local serving P.G.&E..
- E. Small wiring, necessary fuse blocks and terminal blocks within the board shall be furnished when required. All groups of control wires leaving the switchboard shall be provided with terminal blocks with suitable numbering strips. All hardware used on conductors shall have a high tensile strength and an anti-corrosive zinc plating.
- F. A one-piece copper ground bus complete with lugs shall be furnished firmly secured to each vertical section structure and shall extend the entire length of the switchboard and shall be front accessible.
- G. Ground bus current rating to be sized in accordance with CEC table 250.66(a) and 250.122, whichever is larger on the basis of 1,000 amperes per square inch. Ground bus shall be copper.
- H. Switchboard shall be provided with adequate lifting means and shall be capable of being rolled or moved into installation position and bolted directly to the floor without the use of floor sills.
- I. A-B-C type bus arrangement, left-to-right, top-to-bottom, and front-to-rear, as viewed from the front, shall be used throughout.
- J. Record drawings shall be furnished providing the following information: Switchboard voltage/current rating; overall outline dimensions including available conduit space; switching and protective device ampere rating; (bus) conductor ratings; and one line diagram.
- K. Adequate conduit space shall be provided to meet California Electrical Code requirements.
- L. Each switching and protection device shall be provided with visible means of "ON-OFF" and trip rating identification. All terminals shall be of the anti-turn solderless type suitable for copper or aluminum cable of size indicated.

- M. All exterior and interior steel surfaces of the switchboard shall be properly cleaned. The exterior shall be finished with gray ANSI-61 paint over a rust coat inhibiting phosphatized coating. The finish paint shall be of a type to which field applied paint will adhere.
- N. All vertical sections shall have whatever depth is necessary to accommodate and connect equipment. All vertical sections shall align front and/or rear.
- O. The internal components (switching and protective devices, etc.) shall be removable from the front and shall be group mounted with necessary line and load connections accessible.
- P. Busses shall be braced for short-circuit stresses up to 68,000 amperes rms. minimum.
- Q. Switchboard main and distribution circuit breakers shall be molded case bolt-on type with trip rating as scheduled on Drawings.
- R. Switchboard shall be labeled to serve as "Service Entrance Equipment".
- S. Each circuit breaker shall be identified with an engraved laminated phenolic plate showing the load served or the function of the circuit breaker and trip rating. The nameplate shall be attached with oval head machine screws tapped into the front of the board. Equip breaker handles with padlocking "lock-off" devices.
- T. Switchboard shall be completely factory assembled, wired and tested before delivery and shall conform to UL where applicable, WUESSC, California Electrical Code Standards and State of California requirements.
- U. The board shall be as manufactured by Culter Hammer, General Electric, Square D or ITE.
- V. Switchboard dimensions shall not exceed dimensions shown on drawings.

PART 3 - EXECUTION

3.1 SWITCHBOARD INSTALLATION

- A. Level and install in the location shown on the Drawings using 1/2" concrete insert bolts through the bottom frame of the switchboard or fasten to the wall behind using "U" channel spacers at the top and bottom of the switchboard extending its entire length. Maintain 42-inch clear working space the entire length of the switchboard front.
- B. Provide cable supports for all cables from point of entrance to respective circuit breakers.

-END OF SECTION-

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section describes general provisions, products, and methods of execution relating to branch circuit panelboards approved for use on this project. Type, size, ratings, etc., shall be as shown on the plans and in accordance with UL Standards 50 and 67.

1.2 SPECIAL REQUIREMENTS

- A. Special features such as main contactor, submain contactor, split bus, etc., shall be provided if called for on the plans. Trims shall be furnished to be compatible with type of mounting.

1.3 QUALITY ASSURANCE

- A. The panelboards shall be of the latest approved design as manufactured by a nationally recognized manufacturer and be listed in the Underwriters Laboratory and bear the UL label.
- B. Acceptable manufacturers are Square D Company, General Electric Company, ITE or Culter Hammer.

1.4 SUBMITTALS

- A. Submit for approval manufacturer's shop drawings to show weights, dimensions, mounting arrangements, interconnecting diagrams, schedules of all overcurrent devices, voltage ratings, and all specified accessories.
- B. Delete all superfluous information from submittal data such as model numbers and options for equipment contained on manufacturer's data sheets but not used on this project.
- C. Refer to Division 1 for exact submittal requirements.

1.5 WARRANTY

- A. Warrant all components, parts and assemblies against defects in materials and workmanship for a period of twelve (12) months after acceptance.

PART 2 - PRODUCTS

2.1 CABINETS AND FRONTS

- A. Enclosures: Single door with door in door construction, dead front of code gauge steel with trim and door of 12 gauge stretcher-leveled steel. Flush trims shall have no exposed hardware and flush lock. Enclosures shall be 20" wide (minimum) x 5 3/4" deep (maximum), unless otherwise noted. Where flush enclosures are deeper than wall, provide frame to seat trim flush. Refer to panel schedules for exact type, by General Electric, ITE, Square D or Culter Hammer. Switchboard and panels must be by same manufacturer.

- B. Finish with one coat rust resistant primer, one coat gray enamel inside and out. Flush panels and adjacent cabinet or pull boxes, etc., shall be the same color.
- C. Enclosures shall be lockable with flush type combination latch (all keys keyed the same), and two keys shall be furnished with each lock. Mounting height: Top of panel +6'-3" u.n.o.
- D. Install 6" x 8" typewritten directory behind glass or plastic on inside of enclosure door showing circuit number and complete as-built description of all outlets controlled by each circuit breaker. Arrange directly to match actual circuit breaker arrangement within panel, i.e. 2, 4, 6 etc. on right side and 1, 3, 5 etc. on left side, on schedule.

2.2 SAFETY BARRIERS

- A. The panelboard interior assembly shall be dead front with panelboard front removed.

2.3 BUS ASSEMBLY

- A. Busses: Bus capacities as noted on Drawings. Busses shall be made of 98% (or better) conductivity copper bars sized for current density of 1000 amp/sq. inch of cross section area.

2.4 SHORT CIRCUIT RATING

- A. Each panelboard, as a complete unit, shall have a short circuit rating equal to or greater than that shown on the panelboard schedule.

2.5 PROTECTION DEVICES

- A. Circuit breakers shall individually comply with Section 26 05 72 - OVERCURRENT PROTECTIVE DEVICES. The type to be furnished shall be as shown on the plans. If no withstand rating is specified, minimum requirements shall be 22,000 AIC symmetrical at 208 volts, or as determined by Section 26 05 73 – OVERCURRENT PROTECTIVE DEVICE COORDINATION.
- B. Breaker identification: Provide a permanently fixed number of each circuit breaker either engraved or stamped in the panel front or snapped into the body of the circuit. Stick on numbers are not acceptable. Where single-phase circuits are connected to a multiple pole breaker or approved handle tied breakers, each pole shall have a number as indicated on plans. For distribution panels, provide an engraved nameplate by each breaker, screw attached with two oval head screws.

2.6 NEUTRAL TERMINAL AND EQUIPMENT GROUNDING TERMINALS

- A. All panelboards shall be equipped with an insulated copper neutral terminal bar. A copper equipment grounding terminal bar shall be furnished to terminate equipment grounding conductors.
- B. All neutral and ground terminal bars shall be copper.

PART 3 - EXECUTION

3.1 MOUNTING

- A. Verify mounting arrangement for each location shown on the plans. Where cabinets are recessed, verify adequate thickness of wall and make arrangements for furring as required. In general, all conduits shall enter the top or bottom of panel.

3.2 AUXILIARY GUTTERS

- A. Provide additional wire gutters or pull boxes to facilitate orderly entry of conduits into cabinets. Bundle and support wires and arrange them in an orderly manner in the designated wire gutters. Gutters shall be flush with flanged trim where noted.
- B. Panelboards shall not be used for pull boxes for wiring not terminating in the panelboard.

3.3 SPARE CONDUITS

- A. Provide spare conduits from flush mounted panelboard into accessible ceiling and under accessible floor spaces as follows:

Number of Poles Spares or Spaces	Conduits
1-3	One 3/4"
4-6	Two 3/4"
7 or more	Two 3/4", One 1"

3.4 PANELBOARD LABELS

- A. Label panelboards in accordance with Section 26 00 10.
 - 1. First line shall be panelboard name.
 - 2. Second line shall be voltage and phase.

-END OF SECTION-

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section describes general provisions, products and methods of execution relating to line voltage wiring devices approved for use on this project.

1.2 QUALITY ASSURANCE

- A. Manufacturers mentioned and catalog number specified are for establishment of type, configuration and quality. Other manufacturers and types may be submitted for approval.

PART 2 - PRODUCTS

2.1 DEVICES

- A. Provide wiring devices indicated. Catalog numbers shown are Hubbell unless noted otherwise. Equal devices manufactured by Pass and Seymour, Leviton, Bryant, Slater and G.E. are acceptable. Provide all similar devices of same manufacturer. Devices and device plates color shall be as selected by Architect. Provide weatherproof where so noted on drawings.

2.2 SWITCHES

- A. Provide 20 Amp, 120-277V rated switches with UL listing for tungsten lamp loads or inductive loads without derating. Switches shall be as follows:

20A

Single Pole	CAT. NO. 1221
Three-Way	CAT. NO. 1223
Four-Way	CAT. NO. 1224
Key Operated	CAT. NO. 1221-L
Momentary Cont.	CAT. NO. 1557
Double Pole	CAT. NO. 1222
Pilot Switch	CAT.NO.1221-PL
3-Way Pilot Switch	CAT. NO. 1223-PL

- B. Multiple 277V switches shall be installed in partition boxes.
- C. Other switch types shall be provided as called for on the drawings or as required by the application.

2.3 RECEPTACLES

- A. Provide grounding type receptacles as follows, or as required to match equipment furnished in this or other divisions.

Single phase, 3-wire devices

15A-125V	CAT. NO. 5262	NEMA #5-15R
15A-125V GFCI	CAT. NO. GF-5262	NEMA #5-15R
15A-125V Iso. Grnd.	CAT. NO. IG-5262	NEMA #5-15R
15A-250V	CAT. NO. 5662	NEMA #6-15R
Clock hanger 125V	CAT. NO. S-373-3SS	NEMA #5-15R
20A-125V	CAT. NO. 5362-I	NEMA #5-20
20A-125V GFCI	CAT. NO. GF-5362	NEMA #5-20R
20A-125V Iso. Grnd.	CAT. NO. IG-5362	NEMA #5-20R
20A-250V	CAT. NO. 5462	NEMA #6-20R

- B. Outlets requiring ratings color and configurations different from those listed above shall be provided as shown on the plans and/or required by the equipment served.

PART 3 - EXECUTION

3.1 COVER PLATES

- A. Install all wiring devices indicated complete with cover plates. Cover plates shall fit snugly against finished surfaces and line up true with adjacent building lines, and be symmetrical in location and appearance.

3.2 SWITCHES

- A. All switches shall be installed so their handles move in a vertical plane.
- B. Door swings shall be checked and, if necessary, switches shall be relocated to place them on the strike side of the door.

3.3 RECEPTACLES

- A. Receptacles shall not be placed back-to-back in adjacent rooms. They shall be offset at least 12".
- B. Unless otherwise noted on the drawings, receptacles shall be installed in the vertical position with the grounding pin down.

-END OF SECTION-

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section describes general requirements, products, and methods of execution relating to fusible and non-fusible disconnecting devices approved for use on this project.

1.2 QUALITY ASSURANCE

- A. Devices shall be of the latest approved design as manufactured by a nationally recognized manufacturer and in conformity with UL listings and the governing NEMA standards.
- B. Acceptable manufacturers are Square D, General Electric, ITE or Culter Hammer.

PART 2 - PRODUCTS

2.1 SAFETY SWITCHES

- A. Safety switches, fusible and non-fusible, shall conform to NEMA Standard KSI-1975 for type HD (heavy-duty).
- B. Switch Interior: All switches shall have switch blades which are fully visible in the "OFF" position when the door is open. Switches shall be of dead-front construction with permanently attached arc suppressors. Lugs shall be UL listed for copper and/or aluminum cables and be front removable.
- C. Switch Mechanism: Switches shall have a quick-make and quick-break operating handle and mechanism which shall be an integral part of the box, not the cover. Switches shall have a defeatable dual cover interlock to prevent unauthorized opening of the switch door in the "ON" position or closing of the switch mechanism with the door open. The switch shall be capable of being locked in the "OFF" position with three (3) padlocks.
- D. Enclosures: Switch enclosure shall be suitable for the environment in which the switch is mounted. NEMA 1 enclosure shall be code gauge, UL-98, sheet steel, treated with rust inhibiting phosphate and finished in gray, baked enamel. NEMA 3R enclosure--same requirements as NEMA 1 except galvanized prior to painting.
- E. Rating: Ampere, volt and horsepower ratings, as well as number of poles and presence of neutral bar shall be shown on the name plate.

2.2 CIRCUIT BREAKERS

- A. Circuit breakers used as disconnects shall meet requirements specified in Section 26 05 72 - OVERCURRENT PROTECTION. Enclosures for same shall meet the requirements as specified above.

PART 3 - EXECUTION

3.1 RATINGS

- A. Coordinate all details pertaining to size of motor and/or equipment, location and requirements to enclosure, ratings, etc., so as to provide the most suitable unit for the intended purpose.

3.2 LABELS

- A. Provide nameplates for all disconnects in accordance with Section 26 00 10. Coordinate names with mechanical equipment lists.

3.3 FUSING

- A. Where the rating of a fused disconnect exceeds the ampacity of the conductors being protected, a permanent engraved phenolic label noting maximum fuse size shall be installed in a conspicuous location within the switch.
- B. Where recommended or required by the equipment manufacturer, or required by Underwriters Laboratories, disconnects shall be the fusible type, fused in accordance with the equipment nameplate information.
- C. Provide three (3) spare fuses for each type, size and rating of all fuses installed. Provide fuse storage box in main electrical room.

3.4 MOUNTING

- A. Provide all hardware for independently mounting all disconnect switches to building structure.
- B. Disconnect switches may be mounted, attached to mechanical equipment where permitted by equipment manufacturer. Install in accordance with equipment manufacturers instructions.

-END OF SECTION-

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This Section describes general requirements, products and methods of execution relating to outlet boxes for use with wiring devices and lighting fixture outlets approved for use on this project. All boxes shall be sized per CEC Article 370.

1.2 QUALITY ASSURANCE

- A. Underwriters Laboratory listing for intended usage shall constitute proof of acceptable quality.

PART 2 - PRODUCTS

2.1 CAST BOXES

- A. Cast Boxes with threaded hubs and gasketed covers shall be used in the following locations:
1. All exterior locations.
 2. All wet or damp locations.
 3. Shops, mechanical rooms, etc., where exposed to mechanical damage.
 4. Commercial kitchens and/or cafeterias with, or adjacent to, water or steam connections.
 5. Floor boxes installed in concrete.
 6. All exposed interior locations below 48" above floor.
 7. Where shown on drawings.
 8. Detention areas.

2.2 OUTLET BOXES

- A. All outlet boxes shall be of sheet steel, zinc coated at least 1½" deep and carefully sized as to the number of conductors and devices and according to appropriate sections of the CEC. Boxes shall have knockouts for conduit terminations and mounting lugs and ears for covers. Boxes are to be rigidly secured in position set true and square.
- B. Concealed outlet boxes shall not be less than four inches square or rectangular and provided with the proper size knockouts for the conduits used. All unused knockouts must remain closed. Boxes in plaster construction shall be provided with approved covers or plaster rings.
- C. Outlet boxes for wiring devices in finished walls shall be one-piece standard gang type of size to accommodate number of devices noted. Boxes shall have plaster cover to bring box openings flush with finished wall and not more than ¼" back of same.
- D. Mounting dimensions for outlet boxes shown in a general manner on the schedule will be permitted slight adjustments to satisfy block construction on the subject. Those dimensioned on the drawings, however, shall be installed as shown.

- E. All outlets occurring in other than plaster construction shall be provided with flush rectangular square-cornered boxes made for the purpose. Where devices are ganged, gang-type boxes shall be installed.
- F. Boxes shall be of unit construction and of size required by the NEC for the number of devices shown. The shape of the box shall be such as to permit surfacing materials to be cut in straight lines and to fit closely around the box. The box shall be so placed that the cover plate will be flush with the finished wall surface.
- G. All boxes for lighting outlets shall be round or octagonal and provided with fixture studs of a size suitable for the weight of the fixture to be supported. In no case shall the fixture stud be less than 1/8". The stud shall be of integral construction with the box.
- H. Outlet boxes used for exterior outlets or for exposed interior conduit runs shall be of cast rust-resisting metal. Gasketed covers shall be provided where the outlet is exposed to weather or moisture.
- I. Outlet boxes shall be as manufactured by Appleton, Crouse Hinds or approved equal.
- J. Grounding Screw: All stamped steel boxes shall have a drilled and tapped hole in the back of the box for a grounding screw.
- K. Provide security fasteners for all boxes installed in detention areas.

PART 3 - EXECUTION

3.1 OUTLET BOXES SUPPORT

- A. Outlet boxes shall be securely fastened in position and supported independently of the conduit system.
- B. Outlet boxes located in suspended ceiling system shall be fastened to cross-members supported by the main ceiling support members, or from hanger rods with solid supports.

3.2 ALIGNMENT

- A. Boxes shall be installed true to the building lines and at equal heights in conformity with mounting heights specified in other sections of the specifications.
- B. All boxes shall be rigidly secured in position. All boxes shall be so set that the front edge of the box shall be flush with the finished wall or ceiling line, or not more than 1/8" back of same. This requirement is more stringent than CEC requirements.

3.3 BOX TYPES

- A. Provide the best suitable box for each outlet requirement.

- B. Boxes shall have only the holes necessary to accommodate the conduits at point of installation. All boxes shall have lugs or ears to secure covers.

3.4 ACCESSIBILITY

- A. All boxes shall be accessible.

-END OF SECTION-

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This Section describes general provisions, products and methods of execution relating to pull and junction boxes approved for use on this project. Furnish all such boxes, whether shown or not, in order to conform to requirements for maximum pulling length and maximum number of bends allowed.

1.2 QUALITY ASSURANCE

- A. Pull and junction boxes 150 cubic inches and smaller shall conform to specifications for outlet boxes, Section 26 28 17 – OUTLET BOXES.
- B. Pull and junction boxes larger than 150 cubic inches shall conform to UL Standard 50-1970, Cabinets and Boxes. The UL label shall constitute proof of acceptable quality.

1.3 RATINGS

- A. Pull and Junction Boxes shall conform to Article 370 of the CEC and the following requirements:
 - 1. Sheet metal boxes shall be approved for use in all dry, interior, non-hazardous locations.
 - 2. Boxes exposed to rain or installed in wet locations shall be NEMA 3R, 4, or as noted.
 - 3. Boxes installed in underground shall be either precast concrete or cast iron.
 - 4. Special boxes, as noted on the drawings, shall be installed in areas of specific service and/or hazards.

1.4 ACCESSIBILITY

- A. All boxes shall be installed so that covers are readily accessible and adequate working clearance is maintained after completion of the installation.

1.5 GROUNDING

- A. All boxes shall be grounded with conduit grounding bushings.

-END OF SECTION-

PART 1 - GENERAL

1.1 DESCRIPTION OF SYSTEM

- A. Provide an integrated Standby power system to supply electrical power in event of failure of normal supply, consisting of liquid cooled engine, an AC alternator and system controls with all necessary accessories for a complete operating system, including but not limited to the items as specified hereinafter.
- B. Provide an automatic transfer switch described elsewhere in this specification so that the system comes on-line fully automatically, and on restoration of utility power automatically re-transfers load to normal power, shuts down the generator and returns to readiness for another operating cycle.
- C. Provide a double wall above ground, remote mounted fuel storage tank with emergency vents and necessary fittings.

1.2 REQUIREMENTS OF REGULATORY AGENCIES

- A. An electric generating system, consisting of a prime mover, generator, governor, coupling and all controls, must have been tested, as a complete unit, on a representative engineering prototype model of the equipment to be sold.
- B. The automatic transfer switches must be UL listed for use in emergency systems.
- C. The generator set must conform to applicable California Electrical Code and applicable inspection authorities.
- D. The generator set must be available with the Underwriters Laboratories listing as a stationary engine generator assembly.
- E. The generator shall be in compliance with the Air Quality Management District (AQMD). Contractor shall provide AQMD permit.
- F. The above ground, remote mounted fuel tank shall comply with applicable portions of Resource Conservation and Recovery Act (RCRA) pertaining to installation of above ground fuel storage tanks and be compliant with the following reference standards.
 - 1. UL-2085 listed "Protected" tank requirements
 - 2. California Fire Code – CFC 2007, Chapter 34
 - 3. National Fire Protection Association (NFPA): 2002
 - a. NFPA30a- Flammable and Combustible Liquids.
 - 4. U.L. 142, Dual Walled, Steel aboveground storage tanks for flammable and combustible liquids.

1.3 MANUFACTURER QUALIFICATIONS

- A. This system shall include an engine-generator set by Generac, Caterpillar. or Kohler.

- B. The manufacturer shall have printed literature and brochures describing the standard series specified, not a one of a kind fabrication.

1.4 SERVICE

- A. Supplier of each electric plant and associated items shall have permanent service facilities in this trade area. These facilities shall comprise a permanent force of factory trained service personnel on 24 hour call, experienced in servicing this type of equipment, providing warranty and routine maintenance service to afford each owner maximum protection. Delegation of this service responsibility for any of each equipment listed herein will not be considered fulfillment of these specifications. Service contracts shall also be available.

1.5 WARRANTY

- A. The standby electric generating system components, complete engine-generator, automatic transfer switches and instrumentation panel shall be warranted by the manufacturer against defective materials and factory workmanship for a period of 24 months, to include parts and labor. Such defective parts shall be repaired or replaced at the manufacturer's option, free of charge for travel and labor. The warranty period shall commence when the standby power system is first placed into service. Multiple warranties for individual components (engine, alternator, controls, etc.) will not be acceptable. Satisfactory warranty documents must be provided. Also, in the judgment of the specifying authority, the manufacturer supplying the warranty for the complete system must have the necessary financial strength and technical expertise with all components supplied to provide adequate warranty support.

1.6 SUBMITTALS

- A. Provide three sets of Engineering Submittal for approval, prior to production release, showing all components, in addition to the engine and generator. Submittals shall include compliance with these specifications.

PART 2 - PRODUCTS

2.1 ENGINE-GENERATOR SET

- A. The generator shall be open type and include a combination engine-generator set, cooling fan, radiator, mounting rails,, muffler, output circuit breaker(s), unit-mounted controls, and such other components, accessories, parts, tests, documents, and services required to comply with this specification.
- B. The engine-generator set shall be mounted on a heavy duty steel base to maintain proper alignment between components, and shall incorporate vibration isolators of the type and quantity as specified by the set manufacturer. Engine shall be stationary, liquid-cooled for fuel as specified below. Engine shall be capable of driving the generator of this rating on a continuous standby basis for the duration of normal source interruptions per SAE J1349 conditions. Stand-by ratings shall be as shown on the drawings. Engine shall be suitable for use at an elevation of 80' above mean sea level. Engine components shall include the following:

1. A 24 volt DC, solenoid shift, electric starter(s) as required by manufacturer.
 2. Positive displacement, mechanical full pressure lubrication oil pump, full flow lubrication oil filter with replaceable element, pressure relief valve, dipstick oil level indicator and oil drain valve with hose extension.
 3. Dry element air cleaner with replaceable element.
 4. Engine speed electronic governing system to control generator frequency to within 0.25% of rated frequency under steady state load conditions, and capable of parallel operation with load sharing controls.
 5. Engine mounted thermostatically controlled water jacket heater to aid in quick starting. Heater shall be rated 120v, 1,500 watts and be disconnected whenever the engine starts.
 6. Engine protection devices shall have sensing elements located on the engine to initiate the following alarms and engine shutdowns:
 - a. Low coolant temperature alarm
 - b. Low lubrication oil pressure alarm
 - c. High coolant temperature alarm
 - d. Low lubrication oil pressure shutdown with indication
 - e. High coolant temperature shutdown with indication
 - f. Overspeed shutdown with indication
 - g. Overcrank lockout with indication
 - h. Low coolant shutdown that shall activate high engine temperature lamp and shutdown.
 - i. Engine starter battery charging alternator, with solid-state voltage regulator.
- C. Engine cooling system: Engine shall be radiator cooled by engine mounted radiator system including belt-driven pusher fan, coolant pump, and thermostat temperature control. Performance of components shall be as required by the manufacturer. The generator equipment supplier shall furnish and install 50% ethylene glycol antifreeze solution to fill engine cooling system at start-up.
- D. Engine exhaust system: Exhaust muffler shall be furnished for the engine of size as recommended by manufacturer. Muffler shall be of the critical type. Muffler shall be mounted within the protective housing and its weight shall not be supported by the engine. Galvanized steel tail pipe and rain cap shall be furnished by the supplier. Flexible exhaust connection shall be furnished as required for connection between engine exhaust manifold and exhaust line. All exhaust system components shall be properly sized to assure proper operation without excessive back pressure when installed. Make provisions as required for pipe expansion and contraction.
- E. Engine fuel system: Contractor shall provide all rigid fuel system piping sized for proper fuel flow to the engine. Provide all supply lines, pressure regulators, fuel strainers, cut-offs, solenoid valves, vacuum lines, etc., along with all necessary fittings. Provide all connections for fuel system to engine in compliance with

applicable codes and regulations. Reference drawing for correct fuel source. When provided, fuel tank shall be securely bolted in place per recommendations. Fuel storage tanks and related accessories shall be new. A low fuel supply sensing device shall be furnished and installed by the contractor on the line side of the primary regulator. The sensing device shall be adjustable to signal a low fuel level when the tank contains less than a two (2) hour supply based on consumption rate of generator specified.

1. Diesel System: Contractor shall provide a remote, above ground diesel fuel storage tank together with all necessary lines and fittings to provide a complete and operable system. Minimum required fuel capacity shall be sufficient for 120-hour run-time at full load for genset submitted.
 2. Fuel Tank: Diesel fuel tank shall be a fire guard tank-UL2085 in accordance with the applicable requirements.
- F. Generator: Generator shall be single-bearing, self-aligning, four-pole, synchronous type, evolving field, with amortisseur windings, direct drive centrifugal blower for proper cooling and minimum noise, temperature compensated solid-state voltage regulator and brushless rotating rectifier exciter system. Brushes will not be accepted. Generator shall be directly connected to engine flywheel housing and driven through a flexible coupling to insure permanent alignment. Gear driven generators are not acceptable under this specification. Insulation shall meet Class F NEMA standards. The maximum temperature rise shall not exceed 105° C at 40° C ambient. Generator design shall prevent potentially damaging shaft currents. Generator design shall be of the self-protecting type, as demonstrated by the prototype short-circuit test. The generator, exciter, and voltage regulator shall be designed and manufactured by the engine-generator set manufacturer so that the characteristics shall be matched to the torque curve of the prime mover. Leads: The three-phase, broad range, reconnectable generator shall have 12 leads brought out to allow connection by user to obtain any of the available voltages for the unit.
1. Voltage Regulator: Voltage regulator shall be solid-state design and shall function by controlling the exciter magnetic field between stator and rotor to provide no load to full load regulation of rated voltage within 1% during steady-state conditions. The engine-generator set and regulator must sustain at least 90% of no load voltage for ten (10) seconds with 300% of rated load at near zero power factor connected to its terminals. The voltage regulator shall be of an asynchronous pulse width modulated design that is insensitive to severe load induced waveshape distortion from SCR of thyristor circuits such as those used in battery charging (UPS) and motor speed control equipment. A rheostat shall provide a minimum of 5% voltage adjustment from rated value.
 2. Exciter: Exciter shall be three-phase, full-wave, rectified, with heavy-duty silicon diodes mounted on the common rotor shaft and sized for maximum motor starting loads.
- G. Engine-generator set controls: Controls shall have digital LCD type screen for all engine metering, and analog and digital for voltage, amps and frequency displays. Provide a lighted, unit mounted control module that is factory built, wired, tested, and shock-mounted by the manufacturer. Engine-generator set control shall include the following:

1. Indicators: oil pressure gauge, coolant temperature gauge, charge rate volt ammeter and running time meter.
2. Manual selector switch: RUN-OFF/RESET-AUTO.
3. Remote, two-wire controls start-up terminals.
4. Manual reset field circuit breaker.
5. Automatic engine shutdown for the following fault conditions:
 - a. Overcrank
 - b. Overspeed
 - c. Low oil pressure
 - d. High engine temperature
 - e. Low coolant level
 - f. Generator set overload
6. Indicator lamps shall be furnished by the supplier and installed by the contractor to signal the following functions:
 - a. SYSTEM READY - indicates system is in "AUTO" mode.
 - b. PRE LOW OIL PRESSURE - indicates oil pressure is marginally low.
 - c. PRE HIGH ENGINE TEMPERATURE – indicates engine temperature is marginally high.
 - d. LOW OIL PRESSURE - indicates engine has shutdown because of critically low oil pressure.
 - e. LOW COOLANT LEVEL - indicates coolant level is marginally low.
 - f. HIGH ENGINE TEMPERATURE - indicates engine has shut down because of critically high temperature.
 - g. OVERSPEED - indicates engine has shut down because of excessive rpm.
 - h. OVERCRANK - indicates the starter has been locked out because cranking time was excessive.
 - i. LOW ENGINE TEMPERATURE – indicates engine temperature is marginally low for starting.
 - j. LOW FUEL - indicates fuel supply is sufficient for only 2.5 hours run time at full load.
 - k. GENERATOR NOT IN AUTO – indicates control switch is not in the "AUTO" position.
 - l. Provide two additional fault condition lamps to be designated by the engineer.

7. A fault reset switch shall be furnished to clear fault indications and allow restarting of the engine after shut down faults. The control design shall be such that the fault indication shall remain on until reset. The fault indicator memory shall not be dependent on the presence of either AC or DC voltage and shall retain the fault status memory even through complete removal and replacement of the starting batteries. The fault reset function shall operate only when the RUN-OFF/RESET-AUTO switch is in the OFF/RESET position.
8. A locking screwdriver type potentiometer or digital controlled button to adjust the voltage to within 5% of the rated value.
9. Manual reset exciter field circuit breaker.
10. A built-in 5 minute cool-down time delay.
11. A locking screwdriver type potentiometer or digital controlled button to adjust the speed to within 2 RPM of rated value.
12. Indicating AC voltmeter, digital or analog (90-degree scale, 2½" flange, 2% switchboard meter).
13. Indicating AC ammeter, digital or analog (90-degree scale, 2½" flange, 2% switchboard meter).
14. Remote engine kill switch for emergency shut down and lock out.

2.2 ALTERNATOR

- A. The alternator shall be a 4-pole revolving field type, 12 lead, wired for 120/208 VAC, three phase, 60 Hz rated at 80kW depending on total system power configuration, with a PMG driven brushless exciter. Photosensitive components will not be permitted in the rotating exciter. The stator shall be direct connected to the engine to insure permanent alignment. The generator shall meet temperature rise standards for Class "H" insulation. All leads must be extended into an AC connection panel.
- B. One step load acceptance shall be 100% of engine-generator set nameplate rating.
- C. A solid state, digital voltage regulator must be used to maintain the system voltage within +/- 1%. It will have digital communications with the system controller and allow and maintain parallel operation.
- D. The regulator will have a programmable V/F operation which decreases output voltage should the engine RPM rolloff due to application of heavy loads. Under short circuit conditions, it shall maintain 300% of rated current for ten seconds to aid in tripping down stream circuit breakers. It shall have programmable over and under voltage and frequency alarms and shutdowns. The voltage regulator must contain a limiting circuit to prevent output voltage surges in excess of 125% of rated voltage during generator set operation. The waveform harmonic distortion shall not exceed 5% total RMS measured line to line at full rated load. The TIF factor shall not exceed 50.
- E. A panel that is an integral part of the generator set must be provided to allow the installer a convenient location in which to make electrical output connections. A fully rated, isolated neutral bar must be included by the generator set manufacturer to insure proper sizing.

- F. Generator set unit shall be mounted on a welded steel base and supported by spring type vibration isolators supplied by the genset manufacture. Calculations supporting method selected, signed by a registered Structural Engineer, shall be submitted by manufacturer.
- G. A thermal magnetic UL listed main line circuit breaker rated per UL2200 must be mounted in the AC connection panel. The line side connections are to be made at the factory. A system utilizing a manual reset field circuit breaker and current transformers is unacceptable.
- H. The unit mounted main line circuit breaker shall have an internal set of form "C" contacts that change state whenever the breaker is opened or closed in order for proper control operation.

2.3 CONTROLS

- A. All engine alternator controls and instrumentation shall be designed, built, wired, tested and shock mounted in an enclosure to the engine-generator set by the manufacturer.
- B. The engine-generator set control panel shall contain a complete automatic engine start-stop circuit where a digital signal from the remote system controller initiates the start and stop functions of the engine. A programmable cyclic cranking limiter shall be provided to open the starting circuit after the selected number of starting cycles, latching a shutdown fault. Engine control modules must be solid state plug-in type for high reliability and easy service.
- C. The panel shall include; analog meters to monitor AC voltage, AC current and AC frequency with a phase selector switch, an emergency stop switch, an audible alarm, battery charger fuse, and a programmable engine control and monitoring module.
- D. The programmable module shall include: a manual, off, auto switch; four LED's to indicate 1) Not In Auto, 2) Alarm Active, 3) Generator Running, 4) Generator Ready; a data entry keypad and a digital display panel.
- E. The module will display all pertinent unit parameters including:
 - 1. Generator Status
 - a. Current unit status in real time
 - 2. Instrumentation
 - a. Real time readouts of the engine and alternator analog values

- 1) Oil pressure and temperature
 - 2) Coolant temperature and level
 - 3) Fuel level (where applicable)
 - 4) Engine speed
 - 5) DC battery voltage
 - 6) Run time hours
 - 7) Generator voltages, amps, frequency
 - 8) Power, power factor
3. Generator Commands
 - a. Current engine start/stop status
 4. Alarm Status
 - a. Current alarm(s) condition
 - 1) High or low AC voltage
 - 2) High or low battery voltage
 - 3) High or low frequency
 - 4) Low or pre-low oil pressure
 - 5) High and pre-high oil temperature
 - 6) Low water level and temperature
 - 7) High and pre-high engine temperature
 - 8) High, low and critical low fuel levels (where applicable)
 - 9) Overcrank
 - 10) Over and under speed
 - 11) Unit not in "Automatic Mode"
 5. Alarm Log
 - a. Memory of last twenty alarm events
 6. Operating parameters
 - a. Secure access to and manipulation of the operating parameters and alarm limits
 7. Software Information
 - a. Version information and module display test function
- F. The panel must be accessible by PC based software via either standard RS232, RS485 or modem. The software must display the module face, be updated in real time and allow for complete access to all module functions. Communication output and its software must be fully compatible and allow for incorporation into an existing control program.
- G. The following equipment is to be provided by the engine-generator set manufacturer and shipped loose with the unit:

1. Alarm annunciator panel for remote surface mounting with the following signals indicating status and possible malfunction. The annunciator must have the capability of programming the audible alarms as follows:

LAMP LEGEND	LIGHT	AUDIBLE
Pre-Alarm High Water Temperature	YELLOW	SELECTABLE
Pre-alarm Low Oil Pressure	YELLOW	SELECTABLE
High Coolant Temp/Low Coolant Level	RED	YES
Low Oil Pressure	RED	YES
Low Coolant Temperature	YELLOW	SELECTABLE
Low Fuel	YELLOW	SELECTABLE
High Battery Voltage	YELLOW	NO
Not in Auto	RED	YES
RPM Sensor Loss	RED	YES
Over speed	RED	YES
Low Battery Voltage	YELLOW	YES
Overcrank	RED	YES
Generator Power	YELLOW	NO
Normal Utility Power	GREEN	NO
System Ready	GREEN	NO
Alarm Switch Off	RED	NO
Generator Running	YELLOW	NO
Battery Charger Failure	YELLOW	SELECTABLE
Emergency Stop	RED	YES
Communications OK	GREEN	YES

- H. The panel shall have an ALARM switch that when moved to the OFF position silences the audible alarm. A TEST/RESET switch must be included to verify the lights are functional and reset any condition after it has cleared. The remote annunciator shall have a factory installed switch with the capability of starting.

2.4 UNIT ACCESSORIES

- A. The following equipment is to be installed on the engine-generator set at the factory.
 1. Provide an automatic dual rate battery charger. The automatic equalizer system shall monitor and limit the charge current to 10 amps. The output voltage is to be determined by the charge current rate. The charger must have a maximum open circuit voltage of 35 volts and be protected against a reverse polarity connection. The battery charger is to be factory installed on the generator set. Due to line voltage drop concerns, a battery charger mounted in the transfer switch will be unacceptable.

2. A heavy duty, lead acid battery set shall be provided of adequate voltage and amperage capacity to start and operate the engine. Provide all intercell and connecting battery cables as required.
3. Exhaust silencer(s) shall be provided of the size as recommended by the manufacturer and shall be of critical grade. The silencer(s) shall be mounted on the generator set with solid brackets. It shall be connected to the engine with a flexible, seamless, stainless steel exhaust connection. A rain cap will terminate the exhaust pipe. All components must be properly sized to assure operation without excessive backpressure when installed.

2.5 APPLIED STANDARDS

- A. Each unit shall be UL2200.

2.6 FACTORY TESTING

- A. The generator set supplier shall perform a complete operational test on the generator set prior to shipping from the factory. A certified test report shall be provided at closeout. Equipment supplied shall be fully tested at the factory for function and performance. Verify single step load pick-up per NFPA 110. Verify transient and voltage dip responses and steady state voltage and speed (frequency) checks. Verifying all safety shutdowns are functioning properly.
- B. Factory testing for four (4) hours

2.7 OWNER'S MANUALS

- A. Six (6) sets of owner's manuals specific to each product supplied must accompany delivery of each equipment. General operating instruction, preventive maintenance, wiring diagrams, schematics and parts exploded views specific to this model must be included.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Contractor shall install each complete electrical generating system including all fuel connections in accordance with each manufacturer's recommendations as reviewed by each Engineer.

3.2 FUEL TANK DELIVERY, STORAGE AND HANDLING

- A. Handle tanks carefully to prevent damage, breaking, denting, and scoring of tanks and polyurethane overcoat.
- B. Protect from weather dirt, water, construction debris, and physical damage to tanks and polyurethane overcoat.
- C. Install tanks to final location carefully with minimum of handling. Repair damaged surfaces and test for leaks, voids, and holidays.

3.3 FIELD FUNCTIONAL ACCEPTANCE TESTS (FFAT)

- A. The FAT shall be performed by the Supplier from a test plan prepared by the Supplier. The test shall demonstrate on a paragraph-by-paragraph basis that the listed components and subsystems meet the requirements of the specifications. If any component or subsystem fails the FAT the supplier shall correct the problem and shall repeat the test until it is successful.
- B. After completion of the FAT, the supplier shall prepare a test report and shall submit it to the Engineer for review.
- C. The FAT shall be performed on the standby generator, and automatic transfer switch together with all controls, contactors, and safety devices.
- D. The automatic switch may be simulated by external contact closures if unavailable.
- E. The generator set, will be tested under building load, together with all controls and safety devices. The test record shall be provided to the contractor for approval by the Engineer and Owners Representative.
- F. A log shall be provided with the following information:
 - a. The actual settings at which all safety devices operate.
 - b. Voltage and frequency performance, including transient voltage and frequency dip graphs when the generator load is applied in a single step and when a load as specified under PERFORMANCE REQUIREMENTS is applied.
 - c. Unit rating
 - d. Engine and generator serial numbers.
 - e. Additionally, voltage, frequency, amperage, wattage, water temperature, ambient temperature, barometer readings, lubricating oil pressure, lubricating oil temperature, and fuel consumption shall be logged each half hour during the sustained continuous load run.
 - f. The continuous uninterrupted building load test shall run for a period of 4 hours.
- G. The generator set, will be tested under a Portable Resistive Load Bank at Unity Power Factor, together with all controls and safety devices. The test record shall be provided to the contractor for approval by the Engineer and owners Representative.
 - 1. A log shall have entered into it the actual settings at which all safety devices operate. Voltage and frequency performance, including transient voltage and frequency dip graphs when the generator load is applied in a single step and when a load as specified under PERFORMANCE REQUIREMENTS is applied; Unit Rating Engine and generator serial numbers. Additionally, voltage frequency, amperage, wattage, water temperature ambient temperature, barometer readings, lubricating oil pressure, lubrication oil temperature, and fuel consumption shall be logged each half hour during the

sustained continuous load run. The continuous uninterrupted building load test shall run for a period of 4 hours.

2. The Contractor shall make the necessary arrangements, to obtain all required permissions to operate, including verification that the Daily Air Quality Index is compatible for generator operations. This run shall be performed at 0.8 pf (reactive), as tabulated below:
 - a. Hour Percent of Rated Load
 - 1) Initial Start Warm-up – 25 Minutes
 - 2) 5% Load – 25 Minutes.
 - 3) 50% 25 minutes
 - 4) 75% 25 minutes
 - 5) 100% - 3 hours
 - 6) Cool down (No Load) – 25 Minutes
 - H. Take temperature readings again at the end of the cool-down period.
 - I. If for any reason the above 4-hour load run is interrupted, it shall be repeated in its entirety. Any failure during the continuous run of any component included as part of the unit shall be deemed as a failure of the unit as a whole.
 - J. A certified test reports signed by the factory-trained generator technician shall be submitted for review.
 - K. Supply a temporary load bank to supplement any available loads and load bank in order to test the set under the specified loadings. Load banks with unity power factor are suitable for the FAT.
 - L. The FAT is usually performed in the presence of the Engineer or owners representative.
 - M. After completion of the FAT, the Supplier shall prepare a test report and shall submit it for review by the Owner.

3.4 OPERATIONS AND MAINTENANCE MANUALS

- A. The supplier shall provide 6 copies of the Operation and Maintenance manuals for the generator and ATS prior to completion of the work to the contractor.
- B. The manual shall be a bound and covered and be 9-inch by 12-inch in size. Provide a table of contents and one section for each item of equipment specified herein. All pages shall be neatly assembled and fit within the manual cover.
 1. An itemized list of all data provided.
 2. Name and location of the manufacturer, the manufacturer's local representative, the nearest suppliers, and spare parts warehouse.
 3. Recommended installation, adjustment, start up, calibration, and troubleshooting procedures.

4. Recommended lubrication, lubrication intervals, and an estimate of yearly quantity needed.
5. Recommended step-by-step procedures for all modes of operation.
6. Complete internal and connection wiring diagrams.
7. Recommended preventive maintenance procedures and schedule.
8. Complete parts lists, by generic title and identification number.
9. Recommended spare parts and special tools.
10. Disassembly, overhaul, and reassembly instructions.
11. All approved shop drawing information pertinent to facility operation and maintenance.

-END OF SECTION-

PART 1 - GENERAL

1.1 SCOPE

- A. Furnish and install an automatic transfer switch (ATS) with number of poles, amperage, voltage, withstand and close-on ratings as shown on the plans. Each automatic transfer shall consist of an inherently double throw power transfer switch mechanism and a microprocessor controller to provide automatic operation. All transfer switches and controllers shall be the products of the same manufacturer.

1.2 CODES AND STANDARDS

- A. The automatic transfer switches and controls shall conform to the requirements of:
 - 1. UL 1008 - Standard for Transfer Switch Equipment
 - 2. IEC 947-6-1 Low-voltage Switchgear and Controlgear; Multifunction equipment; Automatic Transfer Switching Equipment
 - 3. NFPA 70 - National Electrical Code
 - 4. NFPA 99 - Essential Electrical Systems for Health Care Facilities
 - 5. NFPA 110 - Emergency and Standby Power Systems
 - 6. IEEE Standard 446 - IEEE Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications
 - 7. NEMA Standard ICS10-1993 (formerly ICS2-447) - AC Automatic Transfer Switches
 - 8. UL 508 Industrial Control Equipment

1.3 ACCEPTABLE MANUFACTURERS

- A. Automatic transfer switches shall be ASCO 7000 Series. Generac or Zenith.

PART 2 - PRODUCTS

2.1 MECHANICALLY HELD TRANSFER SWITCH

- A. The transfer switch shall be electrically operated and mechanically held. The electrical operator shall be a momentarily energized, single-solenoid mechanism. Main operators which include overcurrent disconnect devices, linear motors or gears shall not be acceptable. The switch shall be mechanically interlocked to ensure only two possible positions, normal or emergency.
- B. All transfer switch sizes shall use only one type of main operator for ease of maintenance and commonality of parts.
- C. The switch shall be positively locked and unaffected by momentary outages, so that contact pressure is maintained at a constant value and contact temperature rise is minimized for maximum reliability and operating life.
- D. All main contacts shall be silver composition. Switches rated 600 amperes and above shall have segmented, blow-on construction for high withstand and close-on capability and be protected by separate arcing contacts.

- E. Inspection of all contacts shall be possible from the front of the switch without disassembly of operating linkages and without disconnection of power conductors. Switches rated 600 amps and higher shall have front removable and replaceable contacts. All stationary and moveable contacts shall be replaceable without removing power conductors and/or bus bars.
- F. Designs utilizing components of molded-case circuit breakers, contactors, or parts thereof, which are not intended for continuous duty, repetitive switching or transfer between two active power sources are not acceptable.
- G. Where neutral conductors must be switched as shown on the plans, the ATS shall be provided with fully rated overlapping neutral transfer contacts. The neutrals of the normal and emergency power sources shall be connected together only during the transfer and retransfer operation and remain connected together until power source contacts close on the source to which the transfer is being made. The overlapping neutral contacts shall not overlap for a period greater than 100 milliseconds. Neutral switching contacts which do not overlap are not acceptable.
- H. Where neutral conductors are to be solidly connected as shown on the plans, a neutral conductor plate with fully rated AL-CU pressure connectors shall be provided.

2.2 MICROPROCESSOR CONTROLLER

- A. The controller's sensing and logic shall be provided by a single built-in microprocessor for maximum reliability, minimum maintenance, and the ability to communicate serially through an optional serial communication module.
- B. A single controller shall provide twelve selectable nominal voltages for maximum application flexibility and minimal spare part requirements. Voltage sensing shall be true RMS type and shall be accurate to $\pm 1\%$ of nominal voltage. Frequency sensing shall be accurate to $\pm 0.2\%$. The panel shall be capable of operating over a temperature range of -20 to +60 degrees C and storage from -55 to +85 degrees C.
- C. The controller shall be connected to the transfer switch by an interconnecting wiring harness. The harness shall include a keyed disconnect plug to enable the controller to be disconnected from the transfer switch for routine maintenance. Sensing and control logic shall be provided on multi-layer printed circuit boards. Interfacing relays shall be industrial grade plug-in type with dust covers. The panel shall be enclosed with a protective cover and be mounted separately from the transfer switch unit for safety and ease of maintenance. The protective cover shall include a built-in pocket for storage of the operator's manuals.
- D. All customer connections shall be wired to a common terminal block to simplify field-wiring connections.
- E. The controller shall meet or exceed the requirements for Electromagnetic Compatibility (EMC) as follows:

1. IEEE472 (ANSI C37.90A) Ring Wave Test.
2. ENC55011 1991 Class A Conducted and Radiated Emission.
3. EN61000-4-2 Electrostatic Discharge Immunity, Direct Contact & Air Discharge.
4. EN61000-4-3 Radiated Electromagnetic Field Immunity.
5. EN61000-4-4 Electrical Fast Transient Immunity.
6. EN61000-4-5 Surge Immunity.
7. ENV50141 HF Conducted Disturbances Immunity.

2.3 ENCLOSURE

- A. The ATS shall be furnished in a NEMA type 1 enclosure unless otherwise shown on the plans.
- B. All standard and optional door-mounted switches and pilot lights shall be 16-mm industrial grade type or equivalent for easy viewing & replacement. Door controls shall be provided on a separate removable plate, which can be supplied loose for open type units.
- C. The ATS shall be included within the main switchboard section line up as depicted on the electrical drawings

PART 3 - OPERATION

3.1 CONTROLLER DISPLAY AND KEYPAD

- A. A four line, 20 character LCD display and keypad shall be an integral part of the controller for viewing all available data and setting desired operational parameters. Operational parameters shall also be available for viewing and limited control through the serial communications input port. The following parameters shall only be adjustable via DIP switches on the controller:
 1. Nominal line voltage and frequency
 2. Single or three phase sensing
 3. Operating parameter protection
 4. Transfer operating mode configuration shall be open transition.
- B. All instructions and controller settings shall be easily accessible, readable and accomplished without the use of codes, calculations, or instruction manuals.

3.2 VOLTAGE, FREQUENCY AND PHASE ROTATION SENSING

- A. Voltage and frequency on both the normal and emergency sources (as noted below) shall be continuously monitored, with the following pickup, dropout, and trip setting capabilities (values shown as % of nominal unless otherwise specified):

<u>Parameter</u>	<u>Sources</u>	<u>Dropout / Trip</u>	<u>Pickup / Reset</u>
Undervoltage	N&E, 3Φ	70 to 98%	85 to 100%
Overvoltage	N&E, 3Φ	102 to 115%	2% below trip
Underfrequency	N&E	85 to 98%	90 to 100%
Overfrequency	N&E	102 to 110%	2% below trip
Voltage unbalance	N&E	5 to 20%	1% below dropout

- B. Repetitive accuracy of all settings shall be within ± 0.5% over an operating temperature range of -20°C to 60°C.
- C. Voltage and frequency settings shall be field adjustable in 1% increments either locally with the display and keypad or remotely via serial communications port access.
- D. The controller shall be capable (when activated by the keypad or through the serial port) of sensing the phase rotation of both the normal and emergency sources. The source shall be considered unacceptable if the phase rotation is not the preferred rotation selected (ABC or CBA).
- E. Source status screens shall be provided for both normal & emergency to provide digital readout of voltage on all 3 phases, frequency, and phase rotation.

3.3 TIME DELAYS

- A. An adjustable time delay of 0 to 6 seconds shall be provided to override momentary normal source outages and delay all transfer and engine starting signals. Capability shall be provided to extend this time delay to 60 minutes by providing an external 24 VDC power supply.
- B. A time delay shall be provided on transfer to emergency, adjustable from 0 to 60 minutes, for controlled timing of transfer of loads to emergency.
- C. Two time delay modes (which are independently adjustable) shall be provided on re-transfer to normal. One time delay shall be for actual normal power failures and the other for the test mode function. The time delays shall be adjustable from 0 to 60 minutes. Time delay shall be automatically bypassed if the emergency source fails and the normal source is acceptable.
- D. A time delay shall be provided on shut down of engine generator for cool down, adjustable from 0 to 60 minutes.
- E. A time delay activated output signal shall also be provided to drive an external relay(s) for selective load disconnect control. The controller shall have the ability to activate an adjustable 0 to 5 minute time delay in any of the following modes:

1. Prior to transfer only.
 2. Prior to and after transfer.
 3. Normal to emergency only.
 4. Emergency to normal only.
 5. Normal to emergency and emergency to normal.
 6. All transfer conditions or only when both sources are available.
- F. The controller shall also include the following built-in time delays for optional Closed Transition and Delayed Transition operation:
1. 1 to 5 minute time delay on failure to synchronize normal and emergency sources prior to closed transition transfer.
 2. 0.1 to 9.99 second time delay on an extended parallel condition of both power sources during closed transition operation.
 3. 0 to 5 minute time delay for the load disconnect position for delayed transition operation.
- G. All time delays shall be adjustable in 1 second increments, except the extended parallel time, which shall be adjustable in .01 second increments.
- H. All time delays shall be adjustable by using the LCD display and keypad or with a remote device connected to the serial communications port.

3.4 ADDITIONAL FEATURES

- A. A three position momentary-type test switch shall be provided for the test / automatic / reset modes. The test position will simulate a normal source failure. The reset position shall bypass the time delays on either transfer to emergency or retransfer to normal.
- B. A set of DPDT gold-flashed contacts rated 10 amps, 32 VDC shall be provided for a low-voltage engine start signal. The start signal shall prevent dry cranking of the engine by requiring the generator set to reach proper output, and run for the duration of the cool down setting, regardless of whether the normal source restores before the load is transferred.
- C. Auxiliary contacts, rated 10 amps, 250 VAC shall be provided consisting of one contact, closed when the ATS is connected to the normal source and one contact closed, when the ATS is connected to the emergency source.
- D. LED indicating lights (16 mm industrial grade, type 12) shall be provided; one to indicate when the ATS is connected to the normal source (green) and one to indicate when the ATS is connected to the emergency source (red).
- E. LED indicating lights (16 mm industrial grade, type 12) shall be provided and energized by controller outputs. The lights shall provide true source availability of the normal and emergency sources, as determined by the voltage sensing trip and reset settings for each source.
- F. Provide the ability to select "commit/no commit to transfer" to determine whether the load should be transferred to the emergency generator if the normal source restores before the generator is ready to accept the load.

- G. Terminals shall be provided for a remote contact which opens to signal the ATS to transfer to emergency and for remote contacts which open to inhibit transfer to emergency and/or retransfer to normal. Both of these inhibit signals can be activated through the keypad or serial port.
- H. An Inphase monitor shall be provided in the controller. The monitor shall control transfer so that motor load inrush currents do not exceed normal starting currents, and shall not require external control of power sources. The inphase monitor shall be specifically designed for and be the product of the ATS manufacturer. The inphase monitor shall be equal to ASCO Feature 27.
- I. The controller shall be capable of accepting a normally open contact that will allow the transfer switch to function in a non-automatic mode using an external control device.
- J. Engine Exerciser - The controller shall provide an internal engine exerciser. The engine exerciser shall allow the user to program up to seven different exercise routines. For each routine, the user shall be able to:
 - 1. Enable or disable the routine.
 - 2. Enable or disable transfer of the load during routine.
 - 3. Set the start time,
 - a. time of day
 - b. day of week
 - c. week of month (1st, 2nd, 3rd, 4th, alternate or every)
 - 4. Set the duration of the run.
 - a. At the end of the specified duration the switch shall transfer the load back to normal and run the generator for the specified cool down period. A 10-year life battery that supplies power to the real time clock in the event of a power loss will maintain all time and date information.
 - 5. Normal Failed
 - 6. Load on Normal
 - 7. TD Normal to Emerg
 - 8. 2min15s
 - 9. Controllers that require multiple screens to determine system status or display "coded" system status messages, which must be explained by references in the operator's manual, are not permissible.
- K. Self Diagnostics - The controller shall contain a diagnostic screen for the purpose of detecting system errors. This screen shall provide information on the status input signals to the controller which may be preventing load transfer commands from being completed.
- L. Communications Interface – The controller shall be capable of interfacing, through an optional serial communication module, with a network of transfer switches, locally (up to 4000 ft.) or remotely through modem serial communications. Standard software specific for transfer switch applications shall

be available by the transfer switch manufacturer. This software shall allow for the monitoring, control and setup of parameters.

- M. Data Logging – The controller shall have the ability to log data and to maintain the last 99 events, even in the event of total power loss. The following events shall be time and date stamped and maintained in a non-volatile memory:
1. Event Logging
 - a. Data and time and reason for transfer normal to emergency.
 - b. Data and time and reason for transfer emergency to normal.
 - c. Data and time and reason for engine start.
 - d. Data and time engine stopped.
 - e. Data and time emergency source available.
 - f. Data and time emergency source not available.
 2. Statistical Data
 - a. Total number of transfers.
 - b. Total number of transfers due to source failure.
 - c. Total number of days controller is energized.
 - d. Total number of hours both normal and emergency sources are available.
- N. Communications Module - A full duplex RS485 interface shall be installed in the ATS controller to enable serial communications. The serial communications shall be capable of a direct connect or multi-drop configured network. This module shall allow for the seamless integration of existing or new communication transfer devices. The serial communication interface shall be equal to ASCO Accessory 72.

PART 4 - ADDITIONAL REQUIREMENTS

4.1 WITHSTAND AND CLOSING RATINGS

- A. The ATS shall be rated to close on and withstand the available RMS symmetrical short circuit current at the ATS terminals with the type of overcurrent protection shown on the plans.
- B. The ATS shall be UL listed in accordance with UL 1008 and be labeled in accordance with that standard's 1½ and 3 cycle, long-time ratings. ATSs which are not tested and labeled with 1½ and 3 cycle (any breaker) ratings and have series, or specific breaker ratings only, are not acceptable.

4.2 TESTS AND CERTIFICATION

- A. The complete ATS shall be factory tested to ensure proper operation of the individual components and correct overall sequence of operation and to ensure

that the operating transfer time, voltage, frequency and time delay settings are in compliance with the specification requirements.

- B. Upon request, the manufacturer shall provide a notarized letter certifying compliance with all of the requirements of this specification including compliance with the above codes and standards, and withstand and closing ratings. The certification shall identify, by serial number(s), the equipment involved. No exceptions to the specifications, other than those stipulated at the time of the submittal, shall be included in the certification.
- C. The ATS manufacturer shall be certified to ISO 9001 International Quality Standard and the manufacturer shall have third party certification verifying quality assurance in design/development, production, installation and servicing in accordance with ISO 9001.

4.3 SERVICE REPRESENTATION

- A. The ATS manufacturer shall maintain a national service organization of company-employed personnel located throughout the contiguous United States. The service center's personnel must be factory trained and must be on call 24 hours a day, 365 days a year.
- B. The manufacturer shall maintain records of each switch, by serial number, for a minimum of 20 years.

-END OF SECTION-

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes
 - 1. Interior luminaires and accessories.
 - 2. Building mounted exterior luminaires.
 - 3. Exit signs.
 - 4. Luminaire accessories.
 - 5. Security lenses.
- B. Related Documents and Sections
 - 1. Section 26 05 00 - Common Work Results for Electrical.
 - 2. Section 26 05 34 - Outlet and Junction Boxes for Electrical Systems.
 - 3. Section 26 05 35 - Raceway for Electrical Systems.
 - 4. Section 26 05 48 - Vibration and Seismic Controls for Electrical Systems.

1.2 SUBMITTALS

- A. Submit under provisions of Division 1.
- B. Product Data
 - 1. Provide manufacturer dimensions, ratings, and performance data. Identify fixtures by luminaire schedule number. Show all required features and options; include data relative to lenses for security fixtures.
 - 2. Submit lighting level performance data where indicated as required or where an approval of a listed fixture is requested. Provide all assumptions. Indicate whether calculated or measured.
- C. Shop Drawings
 - 1. Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.
- D. Samples
 - 1. Submit samples of security fixtures.
- E. Quality Assurance/Control Submittals
 - 1. Manufacturers' Instructions
 - a. Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements.
 - b. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- F. Closeout Submittals
 - 1. Operation and Maintenance Data
 - a. Submit under provisions of Division 1.

- b. Include replacement parts list.

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements
 - 1. Conform to requirements of CEC.
 - 2. Conform to requirements of CBC.
 - 3. Furnish products listed and classified by UL, or testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown.

1.4 WARRANTY

- A. Provide warranty under provisions of Division 1.
- B. Warrant lenses in writing to County Representative to provide satisfactory performance for 20 years without objectionable discoloration.

1.5 MAINTENANCE

- A. Extra Materials
 - 1. Provide 10 percent or four, whichever is greater, of each type of tempered glass lens.
 - 2. Provide 5 percent or two, whichever is greater of each plastic and other security lens type.
 - 3. Provide 10 percent or one case, whichever is greater, replacement lamp for each lamp installed.

PART 2 - PRODUCTS

2.1 LUMINAIRES - GENERAL

- A. Furnish products as specified in schedule.
 - 1. GENERAL: Lighting fixtures as hereinafter specified are identified by type as noted on drawings. Fixture specifications are based on construction and performance. Manufacturer's catalogue numbers are of general nature and indicate level of quality required, but do not necessarily reflect complete options as specified. Approval shall be based on description and specification of fixture as well as catalogue number indicated. See specifications for fixture, lens, lamp and ballast requirements. Verify fixture voltage requirements with circuitry indicated on drawings.
 - 2. LED fixtures with self-contained emergency battery packs to be U.L. labeled as "EMERGENCY LIGHTING UNITS".
- B. Substitutions: Submit performance calculations for proposed substitutions.
- C. Install drivers, and specified accessories at factory.
- D. Provide all recessed fixtures with gaskets of rubber, fiberglass, or equivalent material to prevent light leaks around flush trim.
- E. Provide standard plaster frame for all recessed lighting fixtures installed in plaster walls or ceilings.

1. Design, finish and fabricate material to preclude possibility of rust stain in plaster.
- F. Coordinate fixture types with ceiling construction.
- G. Provide pendant fixtures with swivel hangers which will allow fixture to swing in any direction but will not permit stem to rotate.
 1. Provide hangers with enclosure rating (NEMA 1, 4, or 7) equal to enclosure requirements of area in which they are installed.
 2. Swivel hangers for fixtures in mechanical equipment areas: Shock absorbing type.
- H. Pendant mounted LED fixtures, in continuous rows shall be supported by conduit and fasten fixtures to each other or mount on continuous metal channel similar to Unistrut. Provide reflector alignment clips on all industrial LED fixtures mounted in continuous rows.
- I. Pendant mounted LED fixtures. Individually mounted to be stem mounted with swivel hangers; 2 for fixtures 1 foot wide and narrower, four for fixtures over 1 foot wide.

2.2 POWER SUPPLY UNIT (DRIVERS)

- A. Luminaires shall be equipped with an L.E.D driver(s) that accepts the voltage as indicated on the "Luminaire (Lighting Fixture) Schedule". Individual driver(s) shall be replaceable.
- B. Driver(s) shall be UL8750 class 2 compliant for their intended purpose.
- C. Total harmonic distortion (THD) for current: $\leq 20\%$.
- D. Driver(s) shall be rated to operate between -30°C to 50°C minimum.
- E. Individual driver(s) shall be equipped with surge protection (6kV minimum) in accordance with IEEE/ANSI C62.4.1. Driver shall be protected against damage due to either an open circuit or short circuit fault condition on the driver output.
- F. Driver(s) shall have a minimum efficiency of 85%.
- G. Drivers shall deliver full-range dimming from 0-10V control signal.

2.3 L.E.D. LIGHT SOURCE (LIGHT ENGINE)

- A. Individual light engine(s) shall be replaceable.
- B. L.E.D. light engine(s) shall have a minimum lifetime of 50,000+ hours at 40°C and shall have a minimum efficiency of 80 lumens per watt.
- C. L.E.D dies shall be tested in accordance with I.E.S.N.A. LM-80-08 standards.
- D. Thermal management shall be passive by design and shall consist of heat sinks with no fans, pumps, or liquids.

2.4 SPARE PARTS

- A. The Contractor shall furnish to the Owner at the completion of the project, a minimum of 5% spare L.E.D. driver assemblies. LED drivers shall be turned over to the Owner representative in their manufacturer's protective packaging. LED drivers not in their protective packaging will not be acceptable.
- B. The Contractor shall furnish to the Owner at the completion of the project, a minimum of 5% spare L.E.D. light engine assemblies. LED light engines shall be turned over to the Owner representative in their manufacturer's protective packaging. L.E.D. light engines not in their protective packaging will not be acceptable.

2.5 EXIT LIGHTS

- A. Exit lights (signs) shall be universal mount and complete with factory installed light-emitting diodes (L.E.D.'s) mounted behind a red diffusing panel and with direction arrows as shown on the drawings.
- B. Exit lights shall have wire guards where shown on the drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Site Verification of Conditions
 - 1. Examine substrate and supporting grids for luminaires.

3.2 INSTALLATION - GENERAL

- A. Install in accordance with manufacturers' instructions.
- B. Mount lighting fixtures at heights indicated. Where not indicated mount:
 - 1. Exit lights - 90 inches above floor. Center in space over door frame where applicable.
 - 2. Bracket light above lavatory - 78 inches above floor.
- C. Install suspended luminaires and exit signs using pendants supported from swivel hangers. Provide pendant length required to suspend luminaire at indicated height.
- D. Support luminaires larger than 2 foot x 4 foot size independent of ceiling framing.
- E. Locate recessed ceiling luminaires as indicated on reflected ceiling plan.
- F. Install surface mounted luminaires and exit signs plumb and adjust to align with building lines and with each other. Secure to prohibit movement.
- G. Exposed Grid Ceilings: Support surface mounted luminaires on grid ceiling directly from building structure.
- H. Install recessed luminaires to permit removal from below.
- I. Install recessed luminaires using accessories and firestopping materials to meet regulatory requirements for fire rating.

- J. Install clips to secure recessed grid-supported luminaires in place.
- K. Install wall mounted luminaires and exit signs at height as indicated on Drawings.
- L. Install accessories furnished with each luminaire.
- M. Connect luminaires, and exit signs to branch circuit outlets provided under Section 26 05 33 using flexible conduit as indicated.
- N. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.
- O. Bond products and metal accessories to branch circuit equipment grounding conductor.
- P. Maintain fire rating of ceiling where luminaire are installed.
- Q. Where a switched fixture with battery backup is used, connect an unswitched lead to the emergency ballast.

3.3 INSTALLATION - SECURITY TYPE

- A. In addition to the requirements elsewhere, the following requirements shall be met:
 - 1. Each maximum or medium security fixture to be attached to concrete structure shall be attached with six 3/8 inch Hilti Kwik Bolts or equivalent with a minimum embedment of 2 inches. Each bolt shall support a minimum of 3000 pound tension in 4,000 psi concrete.
 - 2. Each maximum or medium security fixture to be attached to concrete masonry security wall shall be attached with a minimum of six Hilti Kwik Bolts or equivalent, minimum 3/8 inch diameter, with a minimum embedment of 4 inches into the filled cell of the masonry unit. Do not install bolt at any other point in the masonry unit.
 - 3. Each minimum security fixture to be attached to concrete structure shall be attached with four 3/8 inch Hilti Kwik Bolts or equivalent with a minimum embedment of 2 inches. Each bolt shall support a minimum of 3,000 pound tension in 4,000 psi concrete.
 - 4. Each minimum security fixture to be attached to concrete masonry security wall shall be attached with four 3/8 inch Hilti Kwik Bolts or equivalent with a minimum embedment of 4 inch into the filled cell of the masonry unit. Do not install bolt at any other point in the masonry unit.
 - 5. Each security fixture attached to suspend ceiling system shall be attached with threaded bolt through ceiling to steel channel rigidly attached to ceiling suspension system. Number of bolts as specified by security level of fixture. Mount tight to ceiling.

3.4 FIELD QUALITY CONTROL

- A. Site Tests
 - 1. Test under provision of Division 1.
 - a. Operate each luminaire after installation and connection.

- B. Inspection
 - 1. Inspect for proper connection and operation.

3.5 ADJUSTING

- A. Adjust Work under provisions of Division 1.
- B. Aim and adjust luminaires as indicated on Drawings as directed.
- C. Adjust exit sign directional arrows as indicated.

3.6 CLEANING

- A. Clean Work under provisions of Division 1.
- B. Clean electrical parts to remove conductive and deleterious materials.
- C. Remove dirt and debris from enclosure.
- D. Clean photometric control surfaces as recommended by manufacturer.
- E. Clean finishes and touch up damage.

3.7 DEMONSTRATION

- A. Provide systems demonstration under provisions of Division 1.
- B. Provide minimum of two hours demonstration of luminaire operation.

3.8 LUMINAIRE SCHEDULE

- A. Refer to lighting fixture schedule on drawings.

-END OF SECTION-

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This Specification section identifies the provisions for the telecommunications copper distribution plant as necessitated for the following systems:
 - 1. Data
 - 2. Telephone (Voice)
- B. Furnish and install a complete and fully functional telecommunications copper connectivity system as specified herein and shown within associated construction documentation.
- C. This system shall include, but not limited to submittals, cable, outlets, jacks, punch blocks, patch panels, patch cords, racks, termination, testing, labeling, installation start up and acceptance procedures.
- D. Field coordinate existing conditions and items not in contract, as related to the installation of the copper plant.
- E. Field verify the actual distance of the conduit pathways for appropriating copper cable lengths. End to end copper connectivity lengths shall not exceed 295 feet, provide 10-foot service loop for each horizontal copper termination within The MDF.
- F. All horizontal copper cable shall be plenum rated, all backbone copper cable shall be riser rated.
- G. Products identified within this specification are manufactured Panduit.
- H. Provide for the materials and complete installation of (5) five combination voice and data outlets not shown on Construction Documentation. Horizontal distance for these (5) five outlets shall be 295 feet minimum and location shall be field coordinated upon owner's request.
- I. Construction documentation and general provisions of the Contract, including Division 1 Specification section, General and Supplementary Conditions apply to this section. Where there is a direct conflict or where the requirements of this section exceed those of any other Section or portion of the contract documents; hence, this section shall take precedence.
- J. A qualified telecommunications installation contractor shall perform the copper plant system installation detailed herein. The Contractor shall be experienced and certified in the installation, termination and testing of voice and data copper structured systems. The Contractor shall submit this certification documentation for approval as part of the bid proposal package. Failure to submit such information shall negate validity of contractor ability to perform required work as described.

1.2 SUBMITTALS

- A. Provide submittals in accordance with Division 1.

- B. The following submittals shall be issued and approved by owner's representative prior to the purchase and installation of mentioned materials.
- C. Submit for approval, Manufacture product literature for cable type and test certification of each reel, outlets, jacks, punch blocks, test equipment, tagging labels and any related equipment as described herein.
- D. Submittal shall include wiring diagram indicating voice and data pin-pair termination configuration with color-coding identification.
- E. Submittals and Samples shall be delivered to owner's representative within 15 working days following the award of contract.
- F. Prior to installation, test all twisted pair cable for length, shorts and opens. In addition, test all cable for NEXT and attenuation at 1KHz, 1MHz, 10MHz, 100MHz and 155MHz submit the test results.

PART 2 - PRODUCTS

2.1 HORIZONTAL COPPER CABLE SPECIFICATIONS

- A. Horizontal cable shall be unshielded twisted pair (UTP), #24 AWG round copper conductors.
- B. UTP cable shall conform to ICEA publication S-80 (Revision 10)-576 requirements applicable to inside wiring used for plenum wiring within a building, as required.
- C. UTP cable shall be plenum rated unless otherwise noted. The cable must comply with National Electric Code Articles 725, 760 and 800, where applicable.
- D. The unshielded twisted pair (UTP) cable shall be required to exhibit stable performance in a building and/or exterior environment. The transmission performance of the cable shall not be significantly affected by environment fluctuations, installation or aging. All UTP cable shall be sufficiently free of imperfections as to meet the electrical, mechanical and environmental requirements of this specification.
- E. UTP copper cable shall be new, unused and of current design and manufacturer. All pairs in the cable must be usable and meet required electrical specifications. All pairs in the cable must be insulated with the same material and construction.
- F. Category 3 Copper Cable shall be used for horizontal voice distribution, unshielded twisted pair cable meeting or exceeding all category 3 specifications for material and test criteria as defined by EIA/TIA 568-A. All cable shall be Plenum rated, UL-listed type CMP unless otherwise noted.
- G. Cable must have an ISO 9001 Certification.

2.2 VOICE CABLE

- A. Materials

1. Category 3, 4-pair, Plenum series, possessing the following features/specifications:
 - a. CMP rated for plenum and riser usage.
 - b. Sheath color: Gray.
- B. Manufacturer: General #3NP4P24GYPGCCPV.

2.3 DATA CABLE

- A. Materials
 1. Category 6A, 4-pair, Plenum series, possessing the following features/specifications:
 - a. CMP rated for plenum and riser usage.
 - b. Sheath color: yellow.
 - B. Manufacturer: General #6NP4P24-YL-S-GCC-PV.

2.4 DATA PATCH CORDS

- A. Cable shall have stranded conductors matching the characteristics of the solid conductor Category 6A cable specified herein.
- B. Materials
 1. Category 6A, 4-pair, the possessing the following qualifications:
 - a. CMR rated.
 - b. Factory "connectorized" with RJ45, 8 position, 8-conductor plug.
 - c. Sheath color: yellow
 - d. Length: 7 feet for bidding purposes, field determine prior to purchase.
 - e. Provide 1 patch cord for each RJ45 Jack.
 - C. Manufacturer: General - Yellow.

2.5 MISCELLANEOUS MATERIALS

- A. Tie wraps
 1. Nylon, Plenum rated, sized as required, heavy duty.
 2. Provide Velcro tie wraps for CAT 6A Cable.
- B. Tie Wrap Manufacturer: Panduit or equal.

2.6 DATA PATCH PANELS

- A. RJ-45 jacks, Category 6A data patch panels.
 1. 48 port capacity – Angles, jack snap in.
 2. Tested to 6 levels.
- B. Manufacture: Panduit

2.7 OUTLETS

- A. Each Voice, Data & Voice/Data shall be provided with the components as described in coordination with electrical drawings.
- B. Faceplate Outlets
 - 1. 4-Port, white, Panduit #CFPE4WHY (Executive Series)
 - 2. 6-Port, white, Panduit #CFPE6WHY (Executive Series)
 - 3. Blank Snapin, Panduit #CMBWHY
- C. Data Port
 - 1. Category 6A, RJ-45, Yellow.
 - 2. Panduit #CJ688TPYL-Yellow
- D. Voice Port
 - 1. Category 3, RJ-11, Ivory.
 - 2. Panduit #CJ66UEIY.
- E. Wall Phone Outlet
 - 1. Allen TEL #AT219-4-15.

2.8 WALL MOUNT RACK

- A. APC Netshelter WX 13U with threaded hole vertical mounting rail and glass front door.

2.9 STANDING EQUIPMENT RACK

- A. Server Cabinet: Provide (1) freestanding, 4-post enclosed server cabinet, APC Netshelter (no substitutions). Coordinate exact model number and accessories with Owner IT staff. Provide seismic mounting brackets and mount in IDF room.

2.10 VERTICAL WIRE MANAGERS

- A. For each rack, provide full vertical cable management on each end and between rack sections. Chatsworth MCS, 4.4" wide, double-sided, with hinged covers, or equal.

2.11 HORIZONTAL WIRE MANAGERS

- A. For each rack, provide one (1) horizontal cable manager for each 12 RMU spaces or fraction thereof. Chatsworth "Universal Horizontal Cable Manager" or equal.

2.12 BLANK SPACER PANELS

- A. Panduit #CPAF1BLY, Black

2.13 PATCH PANELS

- A. Patch panels shall be rated Category 6A in 24-port or 48-port high density rack mount configurations. The panels shall have modular RJ45 face and a Category 6A PC board 110 punch down style connectors back, color coded to support both T568A and 568B wiring patterns.
- B. Provide wire management bars for strain relief.

2.14 CAT 6A JACKS

- A. Snap into 72 Port Patch Panels, Panduit #CJ688TPBL-Black
- B. Workstations, Panduit #CJ688TPYL-Yellow.

2.15 CAT 3 VOICE JACKS

- A. Workstation, Panduit #CJ66UEIY.

2.16 VOICE BLOCKS

- A. Nordx/Bix #A0270164-Bix 10A
- B. Nordx/Bix #A0340836-Bix 12E
- C. Voice Feeders – Nordx/Bix #A0266828, 5 Pair Mark
- D. Workstations – Nordx/Bix #A0393146, 4 Pair Mark
- E. X-Connected Field Rings, Nordx/Bix #A0270168

2.17 LADDER RACK

- A. Provide support and cable path above 19" racks.
- B. Chatsworth #10250-712-Black

2.18 BACKBOARD TERMINATIONS

- A. Full blue board (66), Allen Tel #GB183B1-Blue
- B. Full green board (66), Allen Tel #GB183B2-Green
- C. Full white mushroom board (66), Allen Tel #GB187-B1-White
- D. 66 Block M1-50, Siemon Co.
- E. 66 Block M1-25, Siemon Co.

2.19 UPS SYSTEM

- A. Integrated into rack system.

PART 3 - EXECUTION

3.1 CABLING SYSTEM REQUIREMENTS

- A. Install jacks and cables as required for each type of outlet as indicated within telecommunications drawings.

- B. Terminate data cabling on Category 6A RJ-45 patch panels.
- C. Terminate all plant cabling onto protected terminals.

3.2 CABLE INSTALLATION SPECIFICATION

- A. All cables shall be installed in accordance with EIA/TIA 568A specification. In addition, follow the cable manufacturers specifications for each particular cable type.
- B. Install all cables with proper attention paid to bend radii, pulling method, attachment method and pulling forces. Pull cable using appropriate measuring devices to insure that the specified maximum pulling force is not exceeded.
- C. Use appropriate forms to maintain proper radii at cable tray exit/entrances and within ceiling space. Install bending forms in all junction boxes to ensure minimum bend radius. Visually inspect all cable for insufficient bend radius during and after pulling.
- D. Cables shall not be installed on nor rest on ceiling system.
- E. Leave sufficient cable within the overhead system at each drop point such that the outlet or rack location may be reached and that the devices contained therein may be terminated. Provide an 8 to 10 foot service loop left coiled in the ceiling at each drop location. For data cables at data patch panel, leave 10 feet of coiled cable in each rough pull run to allow for termination and dress within the data rack. Excess cable length above that allowed for slack is not acceptable.
- F. Leave nylon pull strings from each outlet to the ceiling space for future cable pulls and in each conduit pathway.
- G. Route and dress cables to avoid congestion, ensure accessibility and guarantee proper maintenance clearance between cable/wire terminals.
- H. Provide and install cable supports for any vertical spans greater than three (3) feet. Use tie wraps for spans of less than six (6) feet and Kellums-type grips or cable runway for spans greater than six feet. (6'). Use Velcro tie wraps for all CAT 6 cables.
- I. Secure cables with Velcro tie wraps where entering or exiting cable trays. Install cables loose in a basket above 19" racks in telecom closets.
- J. Protect all cables from sharp metal edges.
- K. Insure that there is a 20% spare capacity for future horizontal cables at Data patch Panels & at voice Bix blocks.

3.3 LABELING

- A. The Contractor shall legibly label all telecommunications cable per the Owners specific directions and as defined herein.

- B. Install construction labels on all cables as they are pulled. These labels shall contain the same information, as the finished labels as they will be the only labels applied to cables that are not terminated as part of this project. Place labels within 8 feet and again with one foot of each end of all cables. Use typed labels on self-sealing label tape.
- C. The contractor shall employ a cable labeling and tagging scheme that meets owner requirements and as outlined herein.
- D. Each cable shall have a unique number that shall be related to the appropriate faceplate number and jack letter.
- E. Labels shall be numbered according to a scheme developed and approved by Owners representative. The scheme shall include to from information for all tie cables including the building identifier, floor identifier and room identifier. The outlet scheme shall include the building, floor and jack identifiers.

3.4 TESTING

- A. All copper cables shall be tested prior and after installation meeting and or exceeding CABLE TEST PROCEDURES AND LIMITS
 - 1. The Category 6A UTP Data Cables and connector system is designed to provide extended transmission distances over broadened frequency ranges suitable for high speed applications. Category 6A UTP Data Cable and connector performance measurements must conform to transmission specifications and tested in accordance with EIA/TIA 568b.2, and TSB 95 level 2 channels.
 - 2. The station cabling distance from the workstation outlet to the data patch panel located in the telephone room shall not exceed 90 meters or approximately 290 feet.
 - 3. The Category 6A transmission test of UTP Category 6A cables and associated connecting link hardware require the use of a Category 5E cable tester. Connectorization of the equipment must be in accordance with the manufacturer guidelines. Complete 4-pair testing must be performed with full sweep frequency measurements. This test will establish each link's installed performance measurement. This is not a channel certification or a compliance test.
- B. Category 3 voice and Category 6A data testing of every pair shall include each of the following:

1. Opens
2. Shorts
3. Grounds
4. Continuity
5. Polarity, or pair reversals
6. Total loop resistance
7. Low frequency noise level
8. High frequency noise level
9. Impedance
10. Near end crosstalk (NEXT)

11. Jitter
12. Delay

3.5 FIRESTOPS

- A. Install fire stop materials as required by applicable codes and regulations.

3.6 CLEAN UP AND REPAIR

- A. Upon completion of an installation task, the relevant areas and equipment shall be left clean and in operational state.
- B. The contractor shall be responsible for debris removal and repairing any damage caused to the premises by installation activities at no cost to the Owner.

3.7 DATA CABLE TERMINATION AT THE MDF

- A. Terminate all station data cables on the data patch panels as shown on drawings.
- B. Observe all applicable EIA/TIA dressing requirements, including bend radius requirements when installing and terminating the Category 6A UTP cables on the data patch panels.
- C. Label the patch panels and the associated cable as specified herein
- D. Test cable as indicated herein.
- E. All data terminations shall be terminated T568B.

3.8 VOICE CABLE TERMINATION AT THE MDF

- A. Install the specified cables & Bix style blocks at the Telephone backboard for use in terminating the tie cables. Install companion Bix-style blocks on the backboard located within the rack room. Terminate the specified pair cables at both ends under the direction of the Owner IT representative.
- B. Install the specified outside plant voice cables on Bix style protected blocks on the Telephone Backboard for use in establishing the Telephone Utility Point of Demarcation.

- C. Terminate all Category 3 cabling designated for horizontal voice service on the Bix style blocks. Terminate all four pairs of each station voice cable.
- D. Label all cable and components as specified herein as directed by the owner.
- E. All voice terminations shall be terminated with USOC voice jacks.

3.9 OUTLETS

- A. Install the specified outlets where indicated on drawings.
- B. Terminate cables at each outlet.
- C. Observe all EIA/TIA dressing requirements including bend radius when installing and terminating the Category 6A UTP cables on the patch panels and at outlet.
- D. Label & document the cable and outlets as specified herein.

3.10 LABELING

- A. Legibly label all outlets, cable, blocks, frames and patch panels. Consult the Owner for specific directions that may supplement the information contained herein.
- B. The Contractor shall employ a labeling and tagging scheme that meets owner requirements and as outlined herein.
- C. Labels shall be applied according to the scheme illustrated within the Drawings.
- D. All labels shall be machine printed and shall be applied with protective overlays.

3.11 POST INSTALLATION TESTING

- A. Prior to the commencement of the acceptance period, the Contractor shall perform a complete system checkout. Any copper pairs, connectorization, or termination hardware failing to meet the standards listed herein must be removed and replaced, at no cost to Owner, with new materials which prove in subsequent re-testing to meet the standards.
- B. Testing must be done within ten (10) working days following substantial completion. The Owner shall not consider the Work complete until testing has been completed and the system accepted in writing.
- C. After installation, test 100% of all Voice/Data, Category 3/6A voice and data UTP cable.

-END OF SECTION-

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Basic Low Voltage Requirements which are applicable to all Division 28 sections. This section includes information common to two or more technical specification sections or items that are of a general nature, not conveniently fitting into other technical sections.
- B. Reference Standards - Abbreviations of standards organizations referenced in this and other sections are as follows:
 - 1. ANSI, American National Standards Institute
 - 2. ASTM, American Society for Testing and Materials
 - 3. EIA, Electronics Industry Association
 - 4. EPA, Environmental Protection Agency
 - 5. ETL, Electrical Testing Laboratories, Inc.
 - 6. FCC, Federal Communications Commission.
 - 7. IEEE, Institute of Electrical and Electronics Engineers
 - 8. ISA, Instrument Society of America
 - 9. NBS, National Bureau of Standards
 - 10. CEC, California Electric Code
 - 11. NEMA, National Electrical Manufacturers Association
 - 12. NFPA, National Fire Protection Association
 - 13. UL, Underwriters Laboratories Inc.

1.2 REGULATORY REQUIREMENTS

- A. All work and materials are to conform in every detail to applicable rules and requirements of the National Electrical Code (ANSI/NFPA 70), other applicable National Fire Protection Association codes, and present manufacturing standards (including NEMA).

1.3 QUALITY ASSURANCE

- A. Substitution of Materials: Refer to See Section 01 25 00 Substitution Procedures.
- B. Where equipment or accessories are used which differ in arrangement, configuration, dimensions, ratings, or engineering parameters from those indicated on the contract documents, the contractor is responsible for all costs involved in integrating the equipment or accessories into the system and the assigned space and for obtaining the performance from the system into which these items are placed.
- C. All materials shall be listed by and shall bear the label of an approved electrical testing laboratory. If none of the approved electrical testing laboratories has published standards for a particular item, then other national independent testing standards, subject to approval of the Owner's Representative, shall apply and such items shall bear those labels. Where one of the approved electrical testing laboratories has an applicable system listing and label, the entire system shall be so labeled. Approved or listed electrical testing laboratories shall be one of the following:
 - 1. Factory Mutual Laboratories (FM).

2. Underwriters Laboratories, Inc. (UL).
 3. National Electrical Manufacturers Association (NEMA).
- D. All custom built or fabricated items, including relay enclosures, panels, and equipment racks shall be assembled by a UL 508 certified shop.
- E. Qualifications of Contractor: Systems specified in this Division shall be engineered, assembled, and installed by a pre-qualified low voltage electronics systems integrator. The integrator shall meet the following requirements:
1. The low voltage contractor shall have a minimum of 7 years' experience in construction and installation of the systems described herein.
 2. Successful completion of at least ten (10) similar detention facilities which have been in successful operation for at least one (1) year. Provide a listing of project location, Owner point of contact, Owner telephone number, dates of Substantial Completion, dollar value of installed systems and listing of types of systems installed.
 3. Successful completion of at least three (3) projects of similar size and scope to this project, which have been in operation for at least four (4) years. Provide a listing of project location, Owner point of contact, Owner telephone number, dates of Substantial Completion, dollar value of installed systems and listing of types of systems installed.
 4. Technical staff with a minimum of five years' experience in the systems specified, and experience on five (5) similar installations to that specified. Provide resumes for all technical staff that will be working on this project, including each individual's detention experience projects.
 5. Provide a statement indicating the firm has not filed for bankruptcy protection within the past five (5) years.
 6. The integrator shall be bondable for an amount equal to 100% of this bid. Provide a letter from the Surety Company stating that a 100% Payment and Performance Bond will be supplied if selected as the successful integrator.
 7. Provide certification the contractor maintains a UL 508 listed shop.
 8. Provide certification the contractor is licensed in the state in which the work is to be performed.
 9. Pre-qualified Contractors:
 - a. Integrated Security Controls, Inc, Santa Rosa, California, 707-455-6789.
- F. The Division 28 contractor shall be contracted directly to the General Contractor and shall not be contracted to any sub-contractor.

1.4 CODES, PERMITS AND FEES

- A. Refer also to General Conditions of the Contract, Quality Control and Inspection.
- B. The installation of this work shall comply in every way with the requirements of the laws, ordinances and rules of the OSHA, the National Board of Fire Underwriters, and the California Electrical Code.
- C. If any conflict occurs between these rules and this specification, the rules shall govern. Nothing in these drawings and specifications shall be construed to permit work not conforming to governing codes. This shall not be construed as relieving the Contractor from complying with any requirements of the plans or specifications which may be in excess of requirements of hereinbefore mentioned rules and not contrary to same.

- D. Obtain and pay for all required State and local installation inspections. Deliver originals of these certificates to the Owner's Project Representative. Include copies of the certificates in the Operating and Maintenance Instructions.
- E. The Contractor shall include in their bid all utility company fees for any service work related to the building in their bid. If these fees are unattainable prior to bid, contact the Architect or Engineer for instructions.

1.5 INTENT

- A. It is the intent that the Low Voltage Security Electronics Contractor provide the systems indicated in the following specifications sections:
 - 1. 28 00 00 General Low Voltage Requirements.
 - 2. 28 05 01 Equipment Enclosures.
 - 3. 28 05 13 Low Voltage Wire and Cable.
 - 4. 28 05 20 Low Voltage Devices.
 - 5. 28 05 26 Grounding and Bonding.
 - 6. 28 05 28 Low Voltage Security Conduit.
 - 7. 28 05 29 Supporting Devices.
 - 8. 28 05 36 Cable Trays
 - 9. 28 05 53 Low Voltage Identification.
 - 10. 28 13 00 Access Control System.
 - 11. 28 23 00 Closed Circuit Television System.
 - 12. 28 46 19 Programmable Logic Control System.
 - 13. 28 46 23 Touchscreen Control System.
 - 14. 28 46 30 Network Equipment.
 - 15. 28 50 00 Uninterruptible Power Supply.
 - 16. 28 51 23 Detention Intercom and Paging System.
- B. The Contractor shall furnish and install all the necessary materials, apparatus, and devices to complete the low voltage electronics equipment and systems installation herein specified, except such parts as are specifically exempted herein.
- C. If an item is either called for in the specifications or shown on the plans, it shall be considered sufficient for the inclusion of said item in this contract. If a conflict exists within the Specifications or exists within the Drawings, the Contractor shall furnish the item, system, or workmanship which is the highest quality, largest, or most closely fits the Owners Representative's intent (as determined by the Owners Representative's Project Manager). Refer to the General Conditions of the Contract for further clarification.
- D. All details and drawings are diagrammatic, and do not include every interconnect and equipment requirement. The Contractor shall provide all necessary equipment, interfaces, integration, installation, and programming for a complete and operable system.
- E. The Contractor shall verify all dimensions at the site and be responsible for their accuracy.
- F. All sizes given are minimum except as noted.
- G. Materials and labor shall be new (unless noted or stated otherwise), first class, and workmanlike, and shall be subject at all times to the Owners Representative's and/or A/E's inspections, tests and approval from the commencement until the acceptance of the completed work.

- H. Whenever a particular manufacturer's product is named, it is mentioned only to indicate the type, quality and function of the article which will meet the intent of the specifications. See General Conditions of the Contract, Article 17 - Equals and Substitutions.
- I. Schedules are used to identify the field devices shown on the floorplans and/or siteplans and how the field devices are installed. Schedules include references to installation details, termination locations, primary and failover control, and interrelationship to complementary systems.
 - 1. Each field device on the floorplans is identified in the following format: XX-###, where the letters indicate the type of field device, and the last two or three numbers (-###) refer to the number of instances on the floorplans or siteplans. Letter designators (XX-) conform to the following:
 - a. CCTV: Closed Circuit Television field devices.
 - b. CP: Control points, control panels, Touchscreen/GUI workstations, and master intercom stations.
 - c. CR: Access Control field devices.
 - d. DP: Door Position Indication Switch field devices.
 - e. DUR: Duress Alarm Equipment field devices.
 - f. EL: Electric Lock field devices.
 - g. IC: Intercom field devices.
 - h. PA: Paging field devices.
 - i. SE: Miscellaneous Security Electronics field devices including lighting control systems, water control systems, elevators, vehicle detector systems, etc.
 - 2. Tagnames are used within the schedules to identify the interrelation of the devices shown on the floorplans with the how the system is to be controlled. Reference the System Wiring Diagrams to indicate inputs, outputs and/or communications requirements to relays, programmable logic controllers, intercom and audio equipment, and interfacing requirements to hardwired control panels or touchscreens. The following tagname conventions are used:
 - a. Tagnames are identified in the following format: #X#-##, where the first number (#) refers to the controlling panel, the letter and number (X#) refer to the System Wiring Diagram description, and the last two or three numbers (-##) refer to the number of instances the System Wiring Diagram is used.
 - b. Example: 12B1-15 indicates the system is controlled from panel 12, B1 refers to the System Wiring Diagram B1 (shown on either the drawings or specifications), and -15 indicates this is the 15th time the System Wiring Diagram is used.
- J. Software: All software shall be formatted, installed, and programmed in compliance with the Contract Documents and the recommendations of the respective Manufacturer's.

1.6 DEFINITIONS

- A. The following items, when used in Division 28 of the specifications and on the accompanying drawings, shall be construed to mean as follows:

1. Reference CEC Article 100, unless defined otherwise in individual specification sections.
2. Contractor: the contractor for the low voltage security electronics work.
3. Systems Installer, Low Voltage Systems Installer, or LVSE System Installer: the firm, licensed by the State to perform installation of low voltage security electronics systems, which is responsible for immediate supervision and installation of low voltage security electronics work on the project.
4. Provide: Furnish and install, completely ready for use, including all accessories required for operation.
5. Furnish: Purchase and deliver to the project site complete with every necessary appurtenance, support and accessory required for operation.
6. Install: Unload at the delivery point at the site and perform every operation necessary to establish secure mounting and correct operation at the proper location in the project.
7. Concealed: Embedded in masonry or other construction installed behind wall furring, with double partitions or hung ceilings, in crawl spaces, in shafts.
8. Exposed: Not concealed.
9. Underground: Buried within earth, more than 5'0" exterior to building foundations.
10. Underslab: Buried within earth, interior to building foundations.
11. Listed: Equipment is "listed" if of a kind mentioned in a list which:
 - a. Is published by a nationally recognized laboratory which makes periodic inspection of the production of such equipment.
 - b. States that such equipment meets nationally recognized standards or has been tested and found safe for use in a specified manner.
12. Labeled: Equipment is "labeled" if:
 - a. It embodies a valid label, symbol, or other identifying mark of a nationally recognized testing laboratory such as Underwriters' Laboratories, Inc.
 - b. The laboratory makes periodic inspections of the production of such equipment.
 - c. The labeling indicates compliance with nationally recognized standards or tests to determine safe use in a specified manner.
13. Certified: Equipment is "certified" if:
 - a. Equipment has been tested and found by a nationally recognized testing laboratory to meet nationally recognized standards or to be safe for use in a specified manner.
 - b. Production is periodically inspected by a nationally recognized testing laboratory.
 - c. It bears a label, tag, or other record of certification.
14. Inmate Accessible Areas: Areas within the prison project, at and below ten-feet above adjacent floor or grade, except as specifically exempted below, in other specification Sections, or by Owner's Representative.
15. Relocate: Remove and reinstall equipment, or field device to another location. Conduit and wiring shall be extended to the new location.
16. Demolished: Existing to be removed from the project site and disposed, including all associated disconnects, conduit, wiring, relays, switches, and associated equipment.
17. Salvage: Remove and turn over to the Owner.

18. Line Voltage: For the purposes of Division 28, line voltage is defined as circuits operating at 120 volts nominal or greater.
 19. Manufacturer's Representative: Individual certified, in writing, by the equipment manufacturer to be knowledgeable and thoroughly familiar with the installation, programming (if required), testing and troubleshooting of the specific equipment and system configuration installed. If the individual is one other than an employee of the equipment manufacturer, then written certificates proving manufacturer certification must be provided.
 20. Nationally recognized testing laboratory: A testing laboratory which is approved, in accordance with OSHA regulations, by the Secretary of Labor.
 21. Point-To-Point Wiring Data or Point-To-Point Wiring Diagram: Wiring diagrams representing the physical wiring of a the low voltage systems including:
 - a. How each device is physically connected to headend equipment;
 - b. Showing terminal designations of used and unused terminals;
 - c. Showing physical layout of all cabinets, enclosures, terminal boards, relays, and power supplies;
 - d. Showing the terminal designations, wiring designations, and wire tags/colors.
 22. Software Binder: Physical 3-ring binder with pockets including all software, licenses, and source code used for systems specified under this Division.
- B. The following specification development organizations are referenced throughout the various specification sections of Division 28:
1. ADAAG - Americans with Disabilities Act Accessibility Guidelines.
 2. ANSI - American National Standards Institute.
 3. CEC - California Electrical Code.
 4. CMC - California Mechanical Code.
 5. EIA - Electronic Industries Association.
 6. FCC - Federal Communications Commission.
 7. FM - Factory Mutual.
 8. NEMA - National Electrical Manufacturer's Association.
 9. NETA - International Electrical Testing Association.
 10. NFPA - National Fire Protection Association.
 11. NIST - National Institute of Standards and Technology.
 12. UL - Underwriters Laboratories, Inc.

1.7 OMISSIONS

- A. No later than ten (10) days before bid opening, the Contractor shall call the attention of the Owner's Representative to any materials or apparatus the Contractor believes to be inadequate and to any necessary items of work omitted.

1.8 PROJECT/SITE CONDITIONS

- A. Install Work in locations shown on Drawings, unless prevented by Project conditions.

- B. Prepare drawings showing proposed rearrangement of Work to meet Project conditions, including changes to Work specified in other Sections. Obtain permission of the Owner's Representative before proceeding.
- C. Tools, materials and equipment shall be confined to areas designated by the Owner's Representative and user agency.

1.9 WORK SEQUENCE AND SCHEDULING

- A. Install work in phases to accommodate user agency's occupancy requirements. During the construction period coordinate low voltage electronics schedule and operations with the Owner's Representatives:
- B. See the General Conditions of the Contract, Scheduling and Coordination of Work and Time for completion of the project, and General Requirements for additional requirements.

1.10 WORK BY OTHER TRADES

- A. Every attempt has been made to indicate in this trade's specifications and drawings all work required of this Contractor. However, there may be additional specific paragraphs in other trade specifications and addenda, and additional notes on drawings for other trades which pertain to this Trade's work, and thus those additional requirements are hereby made a part of these specifications and drawings.
- B. Low voltage electronics details on drawings for equipment to be provided by others is based on preliminary design data only. This Contractor shall lay out the low voltage electronics work and shall be responsible for its correctness to match equipment actually provided by others.

1.11 CONTRACT DRAWINGS

- A. The contract drawings indicate the extent of low voltage electronics work and the approximate locations and arrangement of the low voltage equipment and devices.
 - 1. The drawings do not necessarily show the exact number of raceways, junction boxes, or outlet boxes for the circuits required, nor does it show the exact routing of the circuits and conduit. The contractor shall field verify routing requirements and coordinate those requirements with other trades as indicated in the paragraph titled COORDINATION.
 - 2. The drawings do not necessarily show the exact number of equipment modules, power supplies, terminal strips, relays, patch panels, network switches, or equipment for the systems indicated, nor does it show the exact placement of equipment on the project. The contractor shall verify all equipment configuration requirements and coordinate those requirements within the spaces indicated on the drawings.
 - 3. The contractor shall provide all raceways, boxes, conductors, connections, supports, and all other materials required for the low voltage systems shown or noted in the contract documents to be complete and fully operational upon completion of the project.
- B. The specifications and drawings are complimentary and what is required in either is as binding as if indicated on both. Where a conflict or discrepancy exists between the drawings and the specifications, the most stringent shall apply.

1.12 RECORD DRAWINGS

- A. The Contractor shall maintain at least one copy each of the specifications and drawings on the job site at all times.
- B. See Division 01 for additional requirements.
- C. The Owner will provide the Contractor with a suitable set of contract drawings on which daily records of changes and deviations from contract shall be recorded. All buried or concealed piping, conduit, or similar items shall be located by dimensions and elevations on the record drawings.
- D. The daily record of changes shall be the responsibility of Contractor's field superintendent. No arbitrary mark-ups will be permitted.
- E. Present the job copy showing variations and changes to date to the Owner's Representative at Construction Progress meetings.
- F. At completion of the project, the Contractor shall submit the marked-up record drawings to the Owner's Representative prior to final payment. See Section 01 77 00 Closeout Procedures and 01 78 00 Closeout Submittals.

1.13 WARRANTY

- A. The Contractor shall warrant the installation to be free from defects in materials and workmanship for a period of one year from Date of Substantial Completion.
- B. During the warranty period, all service (including equipment, labor, travel, expenses, etc.) is to be provided during normal working hours at no cost to the Owner. On-site service must also be made available at times other than normal working hours to the Owner and shall be charged by the integrator's service representatives at current rates of labor and travel. The integrator shall provide the Owner with a manned, 24-hour phone number for service. The integrator shall provide the Owner a phone response within 4 business hours of receipt of service call. The integrator shall provide an on-site response time of one business day for system critical items during regular business hours. "Critical" items are items which compromise the overall security of the facility. Critical item components shall include PLC system components, touch screen control stations, video matrix switching equipment, perimeter detection equipment, officer duress equipment, intercom head-end equipment and uninterruptible power supplies.

1.14 MAINTENANCE SERVICE

- A. A minimum of 60 days prior to the expiration of the warranty, the integrator shall provide a proposal to Owner to provide service and maintenance of the low voltage system installation on a yearly basis. The Owner will be under no obligation to accept the maintenance service proposal.

1.15 MAINTENANCE MATERIALS

- A. Provide maintenance materials under provisions of Section 01 78 23 – Operation and Maintenance Data.
- B. Provide items as identified in each individual specifications section.

PART 2 - PRODUCTS

2.1 APPROVED ELECTRICAL TESTING LABORATORIES

- A. The following laboratories are approved for providing electrical product safety testing and listing services as required in these specifications:
1. Underwriters Laboratories Inc.
 2. Electrical Testing Laboratories, Inc.

2.2 REQUIRED MEETINGS

- A. The following meetings between the Contractor and the Owner's Representative are required during this project:
1. System Architecture Pre-Development Meeting: The Contractor shall provide a system architecture pre-development meeting to discuss network architecture for the PLC/Touchscreen (GUI) system, the CCTV system, the Intercom/Paging system, and the Access Control system. Additionally, the interface requirements of the existing fire alarm system to the new system shall be discussed.
 - a. Location: Online.
 2. Systems Operational Meeting #1: The Contractor shall provide an initial meeting to discuss the operational requirements for the following systems shall be discussed:
 - a. PLC/Touchscreen Control System. Discuss touchscreen (GUI) screen layouts and arrangement, icon representation, audio alarming, and system operation. Discuss fail-over responsibility.
 - 1) The Contractor shall provide an operational Touchscreen Control System demonstration unit consisting of a workstation and/or laptop with a touchscreen, minimize size of 23", during the meeting to discuss operation and layout of the touchscreen graphics.
 - b. CCTV System. Discuss video call-up, cycling of cameras ,areas to be constantly viewed, and which images are displayed at which workstation.
 - c. Intercom/Paging System. Discuss intercom and paging priorities, paging precedence, and intercom roll-over.
 - d. Access Control System. Discuss user groups and access rights for each controlled door.
 - e. Duress Alarm System.
 - f. Location: At the project site and Online.
 3. Systems Operational Meeting #2: Based on input from the first meeting, the Contractor shall review the systems discussed in the first meeting and provide an updated operational review of all systems.
 - a. Location: At the Project Site and Online.
 4. Reference 'Testing and Verification' for additional meetings, in-shop factory testing, and installation testing.
- B. Online meetings shall utilize an online meeting service such as GoToMeeting, WebEx, or similar. The Contractor shall be responsible for setting up, paying for, and inviting attendees for all online meetings.

2.3 SUBMITTALS

- A. General:
1. Partial submittals are not acceptable, and will be considered non-responsive, and will be returned without review.
 2. Submittals not required by the Agreement Documents may not be reviewed and may be discarded.
 3. The contractor may use the contract documents as a basis for all submittals and shop drawings. Electronic copies of all Division 28 drawings and schedules will be made available to the contractor in AutoCAD and Microsoft Excel format, free of charge, for contractor use. Provide a written statement to the Engineer along with a list of the requested documents and schedules as well as a requested means of delivery (CD-ROM, e-mail).
 4. Review comments shall not relieve Contractor from responsibility for deviations from Contract Documents unless attention has been called to such deviations in writing at time of submission, nor shall they relieve this Contractor from responsibility for errors in items submitted.
- B. Substitutions/Prior Submittals
1. Items specified are intended to represent quality and general requirements. It is not the intent of these specifications to prohibit other manufacturers from submitting on substitute materials for review as an acceptable equal. Substitution requests must be submitted in accordance with Section 01 25 00 Substitution Procedures at least seven (7) days prior to the bid. If prior approval has not been requested and granted, then the product manufacturer shall be as noted on the contract documents. The Owner's Representative reserves the right to reject any product that has not been prior approved. It is the Contractor's responsibility to request prior approval, or else provide the product as specified. The Contractor shall be responsible for checking equipment dimensions of proposed substitute equipment and be responsible for its fitting the space allowed. Approval of submittals for products other than those specified is granted with the understanding that any additional cost involved with the installation or performance of the substitute product required to conform with the building design and/or specifications shall be paid for by the Contractor. The cost of any redesigning caused by a substitution shall be borne by the Contractor.
 2. Substitution after the bid will only be allowed for any one of the following reasons:
 - a. The substitute product is approved as a better product by the Owner's Representative, at no increased cost.
 - b. The substitute product is approved as an equal by the Owner's Representative and a credit is offered to the Owner. Reference Division ~1 documents for substitution request procedures.
 - c. The reason for unavailability is discontinuance by manufacturer.
- C. Submittals for Approval:
1. Schedule of Values: Within 30 days after Notice to Proceed, the successful bidder shall furnish a low voltage cost breakdown of each low voltage specifications section broken into materials and labor. Include the following in the cost breakdown: See also Section 01 29 00 Payment Procedures.
 - a. Bonds.

- b. Permits and Fees.
 - c. Cartage, Rentals, Shack.
 - d. Supervision.
 - e. Electrical Warranty.
 - f. Equipment Enclosures.
 - g. Low Voltage Security Conduit.
 - h. Low Voltage Wire and Cable.
 - i. Low Voltage Devices.
 - j. Grounding and Bonding.
 - k. Supporting Devices.
 - l. Low Voltage Identification.
 - m. Programmable Logic Controller System. Include any necessary programming as a separate line item.
 - n. Access Control Systems. Include any necessary programming as a separate line item.
 - o. Touchscreen Control Systems. Include any necessary programming as a separate line item.
 - p. Intercom and Paging Systems. Include any necessary programming as a separate line item.
 - q. Closed Circuit Television Systems. Include any necessary programming as a separate line item.
 - r. Uninterruptible Power Supplies. Include any necessary programming as a separate line item.
 - s. Network Equipment.
2. Provide product data sheet(s) for each type of product specified within Division 28 of these specifications. Data sheets showing multiple products or models shall be clearly marked identifying the specific product or model being proposed. Provide original data sheets only. Fax copies are not acceptable. Product data sheets shall include the specification section that the product is located in at the top of each data sheet.
- a. Product data sheets shall be provided in Adobe Acrobat, pdf format, latest version and shall be provided on CD, DVD, via email, or via secure ftp site.
3. Submit the above required information for all equipment and systems as indicated above and in the respective specification sections, marking each submittal with that specification section number. Mark general catalog sheets and drawings to indicate specific items being submitted and proper identification of equipment by name and/or number, as indicated in the contract documents. Failure to do this may result in the submittal(s) being returned to the Contractor for correction and resubmission. Failing to follow these instructions does not relieve the Contractor from the requirement of meeting the project schedule.
4. Shop drawings, detailing the security electronics system including but not limited to the following:
- a. All drawings shall be drawn to scale that detail racks, enclosures, and/or field devices. All devices shall be shown.

- b. All shop drawings generated for this project shall be created utilizing AutoCAD 2017 or greater file format.
 - 1) Drawings shall be submitted on sheet sizes the same size as the contract documents.
 - 2) Text sizes shall be 3/32" minimum at 1/8"=1'0" scale.
 - 3) Text shall not be rotated on the drawings.
- c. Drawings shall be provided for each field device detailing wiring and mounting instructions.
- d. Point-to-point wiring data shall be provided, utilizing a combination of AutoCAD generated drawings and security control point schedules. The schedules shall be created with Microsoft Excel and shall cross-reference AutoCAD drawings as required. Schedules shall detail all equipment being provided and controlled/monitored by the security electronics system. The schedules shall be organized according to different system functionality. Typical schedules shall include, but not be limited to, sections for cabling information, control locations, door hardware interface, intercom, paging, cameras, CCTV monitors, access control, duress, video visitation, etc. The drawings and schedules shall indicate the wiring of components and all connections to be made. Terminal connections in the equipment shall be numbered to correspond to drawings and schedules for use in making connections. All schedules shall be included with the product data sheets in three ring binders as previously described.
- e. Provide a system and network architecture drawing showing the following:
 - 1) Physical network topology for each networked system.
 - 2) Software architecture for each networked system.
 - 3) System software physical locations for each networked system (i.e. indicate software, modules, add-ons and version of software running on each Touchscreen (GUI) workstation and I/O server.).
 - 4) Submit the above information 14 days prior to the System Architecture Pre-Development Meeting.
- f. Drawings for the PLC configuration shall include model numbers of each component used and all required switch settings for proper operation and configuration of the system.
- g. Provide all Touchscreen (GUI) graphical layouts. Reference Section 28 46 23 - Touchscreen Control System for additional requirements. Submit the required information 14 days prior to the Touchscreen (GUI) Operational Meeting.
- h. Provide floor plan drawings to include the following:
 - 1) Layout of all field devices including device naming and/or tag naming. Minimum scale 1/8"=1'0"
 - 2) Conduit/raceway layout between all field devices to headend equipment. Identify if conduit will be routed below slab, or routed overhead. Minimum scale 1/8"=1'0"

- 3) Conduit/raceway layout between all headend equipment, and between headend equipment and control panel locations. Minimum scale 1/8"=1'0"
 - 4) Control room layouts showing dimensioned arrangement of all control equipment with cabinetry to be provided under other Sections, and all power, data and system interconnect outlets. Minimum scale 1/4"=1'0".
 - 5) Equipment room layouts showing dimensioned arrangement of all equipment, conduit/raceway, outlets, power panels, UPS equipment, and grounding equipment. Minimum scale 1/4"=1'0".
 - i. Drawings of equipment cabinet(s) or racks shall detail the arrangement of all components installed.
 - j. Provide power distribution and power loading detail drawings.
 - 1) Power distribution calculations shall be done in accordance with the latest version of the NEC and shall include the load categories and demand factors required by the NEC.
 - 2) Power system distribution calculations and design spreadsheet shall show power loading for all DC power supply circuits, AC emergency circuits, AC UPS circuits, and AC normal power circuits required by the Low Voltage System. The spreadsheet shall consist of each circuit, each device controlled by the Low Voltage System with each device's steady state and in-rush load, and a loading summary of all device types for each circuit. This design requires coordination with other subcontractors who provide such equipment as (but not limited to) the door locks, lighting circuits, water solenoids, and any other device controlled by the Low Voltage System.
 - k. Provide overall Security Electronics System Riser, Intercom Riser, Ethernet Riser, CCTV Riser, and PLC System Riser diagrams. Drawings shall include all interconnecting wiring, cable types and sizing. Provide manufacturers wire type where required.
 5. Provide wiring diagrams, detailing wiring for power, signal and control, differentiating clearly between manufacturers installed wiring and field installed wiring. Identify terminals to facilitate installation, operation, and maintenance.
 6. On request from the Owner's Representative, the successful bidder shall furnish additional drawings, illustrations, catalog data, performance characteristics, etc.
 7. Submittals shall be grouped to include complete submittals of related systems, products, and accessories in a single submittal. Mark dimensions and values in units to match those specified. Include wiring diagrams of electrically powered equipment.
 8. The above submittals must be approved before fabrication or installation is authorized.
 9. Refer to individual specification sections for additional information required to be incorporated into the Submittals for Approval.
- D. Factory Test Submittals:

1. Submit sample forms for approval for use in the Contractor's in-shop Pre-Functional Test testing.
 2. Submit a complete copy of the Contractor's in-shop Pre-Functional Test for review and approval a minimum of two weeks prior to the Owner's Representative witnessing the in-shop Factory Test.
 3. Submit results of each Factory Test utilizing approved form.
- E. Submittals for Close-out Submittals and As-Built Documentation:
1. Include electronic files in both .pdf and .dwg or .dxf format for the following items:
 - a. Shop Drawings. Shop drawings shall be updated to conform to actual installation.
 - 1) Point-to-point diagrams, wiring diagrams, and construction details for all built-up equipment.
 - 2) A complete list of PLC input and output points referencing each field device being controlled and/or monitored.
 - 3) Rack elevations.
 - 4) Provide all Touchscreen (GUI) graphical layouts at 1:1 scale.
 - 5) Provide a screenshot of each CCTV camera field of view after final Owner acceptance.
 - b. Record Drawings.
 2. Network addressing: All IP based equipment shall be scheduled to include the following:
 - a. Switch designation;
 - b. Switch port number;
 - c. Device number;
 - d. IP address;
 - e. Network subnet mask;
 - f. MAC address.
 - g. Network addressing shall be included in either the Shop Drawings or the Operating and Maintenance Manuals.
 3. Operating and Maintenance Manuals
 - a. See Division 1, GENERAL REQUIREMENTS - Operating and Maintenance Instructions for additional requirements.
 - b. Assemble material in three-ring or post binders, using an index at the front of each volume and tabs for each system or type of equipment. In addition to the data indicated in the General Requirements, include the following information:
 - 1) Copies of all approved submittals.
 - 2) Manufacturer's wiring diagrams for electrically powered equipment.
 - 3) Installation and operating instructions.
 - 4) Records of tests performed to certify compliance with system requirements.

- 5) Certificates of inspection by regulatory agencies.
 - 6) Parts lists for manufactured equipment.
 - 7) Preventive maintenance recommendations and servicing data.
 - 8) Copies of all component warranties and installation warranties.
 - 9) Additional information as indicated in the technical specification sections.
 - 10) Emergency instructions for operational and maintenance requirements.
- c. Provide a “software binder” to the Owner upon final system turnover.
- 1) This software binder shall consist of a three ring, hard cover binder that shall include at a minimum, the following items; all computer manufacturer’s backup/recovery discs, touch screen overlay software driver disc, software drivers for peripheral equipment (i.e. printers), touch screen configuration software licenses, CCTV software, and digital intercom administrator software (if provided).
 - 2) The software binder shall include all source codes and licenses for each system included within these specifications.
 - 3) The software binder shall also include a licensed copy of a PC hard drive cloning software equal to Norton Ghost™. Provide one DVD clone copy of each touch screen control station computer and Security Management Server computer (if shown) in the system.
 - 4) Original passwords (provided at time of final completion) provided to access devices such as CCTV keyboards, Security Management Server, touch screen control stations, digital video recording client software, etc., shall be provided in document format.
 - 5) Turn over to owner all termination point and interconnection schedules, all programming source codes including Touch Screen software, PLC development software, Camera recording software, Camera viewing software, and applicable licenses required for operations, maintenance and changes. This is to also include the touch screen and security management system runtime licenses.
 - 6) Provide one complete software development package including license (issued to the owner). Include all other independent development licenses such as but not limited to CCTV, audio, card access and PLC systems utilized on the project. Provide software programming instruction to the owners designated representative. Programming instruction shall include a detailed explanation of how to create I/O and memory tags, icon creation, event logging, create and edit scripts, PLC modifications, independent system programming

methods (CCTV, audio, card access system, PLC) for all systems on the project.

- d. Reference individual Specification Sections for additional requirements.

PART 3 - EXECUTION

3.1 ELECTRONIC SOFTWARE STANDARDS

- A. Design and drawing software for Shop Drawings, Record Drawings, etc shall be the following:
 - 1. Computer Aided Design (CAD): AutoCAD, 2020.
 - 2. Building Information Modeling (BIM): Revit, 2020.
 - 3. Graphic Conventions for Text and Notes: The minimum text size shall be 3/32" (2.5mm).

3.2 INSTALLATION OF LOW VOLTAGE ELECTRONICS SYSTEMS

- A. Electronic equipment installed in control rooms and low voltage electronics rooms shall not be installed until after the environment is free of all dust. A dust free environment shall be defined as follows:
 - 1. All concrete, gypsum wallboard, and tile cutting and patching is complete or other dust producing construction operation is complete.
 - 2. All fireproofing is complete.
 - 3. All painting is complete.
 - 4. All ceiling materials are installed.
 - 5. All air handling systems serving these areas have been in operation for at least one week, and the filters have been changed at least once prior to electronics equipment installation.
- B. All cabling for systems indicated in these specifications shall be installed in conduit, unless indicated otherwise elsewhere within these specifications.

3.3 CONTINUITY OF EXISTING SERVICES AND SYSTEMS

- A. No outages shall be permitted on existing systems except at the time and during the interval specified by the user agency and by the Owner's Representative. The Owner will require written approval. Any outage must be scheduled when the interruption causes the least interference with normal schedules and business routines. No extra costs will be paid to the Contractor for such outages which must occur outside of regular weekly working hours. Written approval must be requested a minimum of 14 days in advance of the scheduled outage.
- B. Any circuit interrupted as a result of this work shall be restored to proper operation by this Contractor as soon as possible. Note that institutional operations are on a seven day week schedule.

3.4 PROTECTION OF FINISHED SURFACES

- A. See Division 1, GENERAL REQUIREMENTS - Protection of Finished Construction for additional requirements.
- B. Furnish one can of touch-up paint for each different color factory finish which is to be the final finished surface of each product furnished by the Contractor. Deliver touch-up paint with other maintenance and replacement material.

3.5 CUTTING AND PATCHING

- A. Refer to Division 01 for additional requirements.
- B. Cutting of concrete or other building materials shall be avoided where possible. The Contractor shall have a workman present at the pouring of concrete and at the building of any masonry that contains electrical work.
- C. All cutting and patching of new and existing construction required for the installation of systems and equipment specified in Division 26 shall be the responsibility of the Division 26 Contractor. All cutting shall be accomplished with masonry saws, drills or similar equipment to provide neat uniform openings.
- D. Patch and repair walls, floors, ceilings and roof with materials of same quality and appearance as adjacent surfaces unless otherwise shown. Surface finishes shall exactly match existing finishes of same materials. All patching shall meet the approval of the Owner's Representative.
- E. All cutting and patching made necessary to repair defective equipment, defective workmanship or by neglect of this Contractor to properly anticipate his requirements shall be included in this Contract.
- F. Cut carefully to minimize necessity for repairs to existing work. Do not cut beams, columns, or trusses or other structural members without the Owner Representative's written approval.
- G. Cutting, patching, repairing, and replacing pavement, sidewalks, roads, and curbs to permit installation of work specified or indicated under this Division is included in this Contract.
- H. Penetrations of Existing Fire Rated Assemblies:
 - 1. Prior to starting construction, the Contractor must obtain a permit from Consolidated Support Services (CSS) in accordance with CSS C-41 Work Directive. Reference Section 01 35 10 Special Procedures and form attached at the end of that section.

3.6 BUILDING ACCESS

- A. Institutional Facilities: When working in institutional facilities escorts are required in all areas of the facility. Reference Section 01 14 00 Work Restrictions.
- B. Arrange for the necessary openings in the building to allow for admittance of all apparatus. When the building access was not previously arranged and must be provided by this contractor, restore any opening to its original condition after the apparatus has been brought into the building.

3.7 EQUIPMENT ACCESS

- A. Install all piping, conduit, ductwork, panels, and accessories to permit access to equipment for maintenance. Coordinate the exact location of wall and ceiling access panels and doors with the General Contractor, making sure that access is available for all equipment and specialties. Where access is required in plaster or drywall walls or ceilings, furnish the access doors to the General Contractor and reimburse the General Contractor for installation of those access doors.
- B. Working Clearances: Minimum installed equipment working clearances as required by the CEC Table 110-34(a) shall be used. The clearances shall be

based on phase-to-phase voltage and condition 3 of that table. As a minimum, there shall be 3 feet of clearance in front of all panels and enclosures.

3.8 COORDINATION

- A. The Contractor shall cooperate with other trades and the Owner's Representative in locating work in a proper manner. Should it be necessary to raise or lower or move longitudinally any part of the low voltage work to better fit the general installation, such work shall be done at no extra cost to the Owner, provided such decision is reached prior to actual installation. The Contractor shall check location of low voltage devices with respect to other installations before installing.
- B. The Contractor shall verify that all devices are compatible for the surfaces on which they will be used. This includes, but is not limited to, fire alarm devices, intercom stations, speakers, panels and enclosures, pushbuttons, card readers, etc.
- C. Coordinate all work with other contractors prior to installation. Any installed work that is not coordinated and that interferes with other contractor's work shall be removed or relocated at the installing contractor's expense.

3.9 TRAINING OF USER AGENCY'S PERSONNEL

- A. Instruct user agency's personnel in the proper operation of systems and equipment provided as part of this project; video tape all training sessions and provide two (2) digital video disks of all training. Include not less than forty (40) hours of instruction. Demonstrate startup and shutdown procedures for all equipment. All training to be during normal working hours.
- B. Instruct user agency's personnel in the proper maintenance of systems and equipment provided as part of this project; video tape all training sessions and provide two (2) digital video disks of all training. Include not less than forty (40) hours of instruction, using the Operating and Maintenance manuals during this instruction. Demonstrate startup and shutdown procedures for all equipment. All training to be during normal working hours.

3.10 HOUSEKEEPING AND CLEAN UP

- A. See Division 1, GENERAL REQUIREMENTS - Cleaning for additional requirements.
 - 1. The Contractor shall clean up and remove from the premises, on a daily basis, all debris and rubbish resulting from its work and shall repair all damage to new and existing equipment resulting from its work. When job is complete, this Contractor shall remove all tools, excess material and equipment, etc., from the site.

3.11 TESTING AND VERIFICATION

- A. Verification by Test and Demonstration: The Contractor shall verify by demonstrations or tests that the requirements of this Specification have been met. All demonstrations and testing shall be witnessed by the Owner's Representative.
- B. The Owner's Representative shall be notified in writing at least fourteen days in advance of all testing. Should the Owner's Representative be unable to attend, the testing shall be re-scheduled at the convenience of both the Contractor and the Owner's Representative.

- C. In-Shop Testing: The Contractor shall provide testing of all equipment assembled in shop prior to delivery to the project site. All shop assembled equipment shall not be delivered to the project site without an in-shop Factory Test, witnessed by the Owner's Representative.
1. Prior to the in-shop Factory Test, the Contractor shall perform a complete Pre-Functional Test to ensure all devices and functions listed below are fully operational prior to the Owner's Representative witnessing the in-shop Factory Test. The Contractor shall submit a sample Pre-Functional Test form for approval, and two weeks prior the Owner's Representative witnessing the in-shop Factory Test, the Contractor shall submit the complete results of the Pre-Functional Test for approval.
 2. The in-shop Factory Test shall be witnessed by the Owner's Representative, shall demonstrate that the following items operate in accordance with the Contract Documents:
 - a. Following in-shop assembly and Contractor testing, the Contractor shall perform the following tests, prior to shipping equipment to the site, in the presence of the Owner's representative to ensure operation in accordance with the contract documents:
 - b. Test of all central CPUs, workstations, peripherals, and all panel control functions.
 - c. Test of all hardwired control panels.
 - d. Test electrical supervision of all input/output sensor and data communication bus circuits.
 - e. Test of all alarm initiating devices and door control operations.
 - 1) Provide a minimum of one type of each type of door alarming and control device to verify system operation. The Contractor shall reconnect the necessary devices to simulate field conditions of each and every system input and output.
 - f. Test of closed circuit television system components, cameras, switchers, and monitors. Each and every camera shall be set up, powered, and connected to the CCTV system to verify operation for the in-shop Factory Test.
 - g. Test of access control system to include tie-in to all related systems.
 - 1) Provide a minimum of one type of each type of access control device to verify system operation. The Contractor shall reconnect the necessary devices to simulate field conditions of each and every system input and output.
 - h. Visual inspection of all wiring.
 - i. Test of all intercommunications and paging system components including amplifiers, staff stations, administrative stations, call stations, and wiring system.
 - 1) Provide a minimum of one type of each type of intercom and paging device to verify system operation. The Contractor shall reconnect the necessary devices to

- simulate field conditions of each and every system input and output.
- 2) Where IP connected devices are indicated on the drawings and/or within the specifications, the Contractor shall set up each and every IP connected device for the in-shop Factory Test.
 - j. Demonstrate software, alarm, control, and display functions of all microprocessor systems.
 - k. Verification of systems response time.
 - l. Demonstrate all rack mounted UPS systems.
 - m. Demonstrate all network communications systems.
 - n. Any deficiencies shall be corrected by the Contractor, and the corrective action witnessed by the Owner's Representative, prior to shipment of the equipment to the project site. Note: this requirement may result in multiple demonstrations to the Owner's Representative.
3. The travel costs for the Owner's Representative to witness the above in-shop tests shall be included within the Contractor's bid. This shall include airfare, car rental, per diem, and overnight lodging costs which shall be billed by the Owner's Representative to the Contractor at 1.1 times actual costs. Additionally, the Contractor will be billed for subsequent tests after the first test at a rate of \$3200 per day.
- D. Field Testing and Commissioning: Following installation and on-site Contractor testing, the Contractor shall perform the following tests, after installation and prior to Substantial Completion, in the presence of the Owner's Representative to ensure operation in accordance with the contract documents:
1. Test of all central CPUs, workstations, peripherals, and all panel control functions.
 2. Test electrical supervision of all input/output sensor and data communication bus circuits.
 3. Test of all alarm initiating devices and door control operations.
 4. Test of closed circuit television system components, cameras, switchers, and monitors.
 5. Test of access control system to include tie-in to all related systems.
 6. Visual inspection of all wiring.
 7. Test of all intercommunications and paging system components including amplifiers, staff stations, administrative stations, call stations, and wiring system.
 8. Test of battery and battery chargers.
 9. Complete operation tests under emergency power, including switchover from normal to emergency power.
 10. Demonstrate software, alarm, control, and display functions of all microprocessor systems.
 11. Demonstrate and test system network failure modes.
 12. Verification of systems response time.
 13. The above testing will require additional time as the Owner's Representative will test all control functions first from the Control Room or control point, and then test all field devices.
- E. In the event that the Architect and/or Engineer are required to witness a retest at a later date because the Contractor is not adequately prepared to conduct the acceptance tests or because the systems being tested have failed such tests,

which shall be solely determined by the Architect, the costs of witnessing additional tests (based on time and materials at the established rates of the Architect and Engineer) shall be borne exclusively by the Contractor. In such an event, a change order to the General Construction Contract will be executed for compensation of the Architect and Engineer witnessing the tests.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Basic Low Voltage Requirements which are applicable to all Division 28 sections. This section includes information common to two or more technical specification sections or items that are of a general nature, not conveniently fitting into other technical sections.
- B. Reference Standards - Abbreviations of standards organizations referenced in this and other sections are as follows:
 - 1. ANSI, American National Standards Institute
 - 2. ASTM, American Society for Testing and Materials
 - 3. EIA, Electronics Industry Association
 - 4. EPA, Environmental Protection Agency
 - 5. ETL, Electrical Testing Laboratories, Inc.
 - 6. FCC, Federal Communications Commission.
 - 7. IEEE, Institute of Electrical and Electronics Engineers
 - 8. ISA, Instrument Society of America
 - 9. NBS, National Bureau of Standards
 - 10. CEC, California Electric Code
 - 11. NEMA, National Electrical Manufacturers Association
 - 12. NFPA, National Fire Protection Association
 - 13. UL, Underwriters Laboratories Inc.

1.2 REGULATORY REQUIREMENTS

- A. All work and materials are to conform in every detail to applicable rules and requirements of the National Electrical Code (ANSI/NFPA 70), other applicable National Fire Protection Association codes, and present manufacturing standards (including NEMA).

1.3 QUALITY ASSURANCE

- A. Substitution of Materials: Refer to See Section 01 25 00 Substitution Procedures.
- B. Where equipment or accessories are used which differ in arrangement, configuration, dimensions, ratings, or engineering parameters from those indicated on the contract documents, the contractor is responsible for all costs involved in integrating the equipment or accessories into the system and the assigned space and for obtaining the performance from the system into which these items are placed.
- C. All materials shall be listed by and shall bear the label of an approved electrical testing laboratory. If none of the approved electrical testing laboratories has published standards for a particular item, then other national independent testing standards, subject to approval of the Owner's Representative, shall apply and such items shall bear those labels. Where one of the approved electrical testing laboratories has an applicable system listing and label, the entire system shall be so labeled. Approved or listed electrical testing laboratories shall be one of the following:
 - 1. Factory Mutual Laboratories (FM).

2. Underwriters Laboratories, Inc. (UL).
 3. National Electrical Manufacturers Association (NEMA).
- D. All custom built or fabricated items, including relay enclosures, panels, and equipment racks shall be assembled by a UL 508 certified shop.
- E. Qualifications of Contractor: Systems specified in this Division shall be engineered, assembled, and installed by a pre-qualified low voltage electronics systems integrator. The integrator shall meet the following requirements:
1. The low voltage contractor shall have a minimum of 7 years' experience in construction and installation of the systems described herein.
 2. Successful completion of at least ten (10) similar detention facilities which have been in successful operation for at least one (1) year. Provide a listing of project location, Owner point of contact, Owner telephone number, dates of Substantial Completion, dollar value of installed systems and listing of types of systems installed.
 3. Successful completion of at least three (3) projects of similar size and scope to this project, which have been in operation for at least four (4) years. Provide a listing of project location, Owner point of contact, Owner telephone number, dates of Substantial Completion, dollar value of installed systems and listing of types of systems installed.
 4. Technical staff with a minimum of five years' experience in the systems specified, and experience on five (5) similar installations to that specified. Provide resumes for all technical staff that will be working on this project, including each individual's detention experience projects.
 5. Provide a statement indicating the firm has not filed for bankruptcy protection within the past five (5) years.
 6. The integrator shall be bondable for an amount equal to 100% of this bid. Provide a letter from the Surety Company stating that a 100% Payment and Performance Bond will be supplied if selected as the successful integrator.
 7. Provide certification the contractor maintains a UL 508 listed shop.
 8. Provide certification the contractor is licensed in the state in which the work is to be performed.
 9. Pre-qualified Contractors:
 - a. Integrated Security Controls, Inc, Santa Rosa, California, 707-455-6789.
 - b. Or accepted Equal. Prequalification submittal demonstrating the requirements listed above must be submitted 14 days prior to bid date.

1.4 CODES, PERMITS AND FEES

- A. Refer also to General Conditions of the Contract, Quality Control and Inspection.
- B. The installation of this work shall comply in every way with the requirements of the laws, ordinances and rules of the OSHA, the National Board of Fire Underwriters, and the California Electrical Code.
- C. If any conflict occurs between these rules and this specification, the rules shall govern. Nothing in these drawings and specifications shall be construed to permit work not conforming to governing codes. This shall not be construed as relieving the Contractor from complying with any requirements of the plans or specifications which may be in excess of requirements of hereinbefore mentioned rules and not contrary to same.

- D. Obtain and pay for all required State and local installation inspections. Deliver originals of these certificates to the Owner's Project Representative. Include copies of the certificates in the Operating and Maintenance Instructions.
- E. The Contractor shall include in their bid all utility company fees for any service work related to the building in their bid. If these fees are unattainable prior to bid, contact the Architect or Engineer for instructions.

1.5 INTENT

- A. It is the intent that the Low Voltage Security Electronics Contractor provide the systems indicated in the following specifications sections:
 - 1. 28 00 00 General Low Voltage Requirements.
 - 2. 28 13 00 Access Control System.
 - 3. 28 23 00 Closed Circuit Television System.
 - 4. 28 46 19 Programmable Logic Control System.
 - 5. 28 46 23 Touchscreen Control System.
 - 6. 28 46 30 Network Equipment.
 - 7. 28 50 00 Uninterruptible Power Supply.
 - 8. 28 51 23 Detention Intercom and Paging System.
- B. The Contractor shall furnish and install all the necessary materials, apparatus, and devices to complete the low voltage electronics equipment and systems installation herein specified, except such parts as are specifically exempted herein.
- C. If an item is either called for in the specifications or shown on the plans, it shall be considered sufficient for the inclusion of said item in this contract. If a conflict exists within the Specifications or exists within the Drawings, the Contractor shall furnish the item, system, or workmanship which is the highest quality, largest, or most closely fits the Owners Representative's intent (as determined by the Owners Representative's Project Manager). Refer to the General Conditions of the Contract for further clarification.
- D. All details and drawings are diagrammatic, and do not include every interconnect and equipment requirement. The Contractor shall provide all necessary equipment, interfaces, integration, installation, and programming for a complete and operable system.
- E. The Contractor shall verify all dimensions at the site and be responsible for their accuracy.
- F. All sizes given are minimum except as noted.
- G. Materials and labor shall be new (unless noted or stated otherwise), first class, and workmanlike, and shall be subject at all times to the Owners Representative's and/or A/E's inspections, tests and approval from the commencement until the acceptance of the completed work.
- H. Whenever a particular manufacturer's product is named, it is mentioned only to indicate the type, quality and function of the article which will meet the intent of the specifications. See General Conditions of the Contract, Article 17 - Equals and Substitutions.
- I. Schedules are used to identify the field devices shown on the floorplans and/or siteplans and how the field devices are installed. Schedules include references

to installation details, termination locations, primary and failover control, and interrelationship to complementary systems.

1. Each field device on the floorplans is identified in the following format: XX-###, where the letters indicate the type of field device, and the last two or three numbers (-###) refer to the number of instances on the floorplans or siteplans. Letter designators (XX-) conform to the following:
 - a. CCTV: Closed Circuit Television field devices.
 - b. CP: Control points, control panels, Touchscreen/GUI workstations, and master intercom stations.
 - c. CR: Access Control field devices.
 - d. DP: Door Position Indication Switch field devices.
 - e. DUR: Duress Alarm Equipment field devices.
 - f. EL: Electric Lock field devices.
 - g. IC: Intercom field devices.
 - h. PA: Paging field devices.
 - i. SE: Miscellaneous Security Electronics field devices including lighting control systems, water control systems, elevators, vehicle detector systems, etc.
 2. Tagnames are used within the schedules to identify the interrelation of the devices shown on the floorplans with the how the system is to be controlled. Reference the System Wiring Diagrams to indicate inputs, outputs and/or communications requirements to relays, programmable logic controllers, intercom and audio equipment, and interfacing requirements to hardwired control panels or touchscreens. The following tagname conventions are used:
 - a. Tagnames are identified in the following format: #X#-##, where the first number (#) refers to the controlling panel, the letter and number (X#) refer to the System Wiring Diagram description, and the last two or three numbers (-##) refer to the number of instances the System Wiring Diagram is used.
 - b. Example: 12B1-15 indicates the system is controlled from panel 12, B1 refers to the System Wiring Diagram B1 (shown on either the drawings or specifications), and -15 indicates this is the 15th time the System Wiring Diagram is used.
- J. Software: All software shall be formatted, installed, and programmed in compliance with the Contract Documents and the recommendations of the respective Manufacturer's.

1.6 DEFINITIONS

- A. The following items, when used in Division 28 of the specifications and on the accompanying drawings, shall be construed to mean as follows:
1. Reference CEC Article 100, unless defined otherwise in individual specification sections.
 2. Contractor: the contractor for the low voltage security electronics work.
 3. Systems Installer, Low Voltage Systems Installer, or LVSE System Installer: the firm, licensed by the State to perform installation of low voltage security electronics systems, which is responsible for immediate

- supervision and installation of low voltage security electronics work on the project.
4. Provide: Furnish and install, completely ready for use, including all accessories required for operation.
 5. Furnish: Purchase and deliver to the project site complete with every necessary appurtenance, support and accessory required for operation.
 6. Install: Unload at the delivery point at the site and perform every operation necessary to establish secure mounting and correct operation at the proper location in the project.
 7. Concealed: Embedded in masonry or other construction installed behind wall furring, with double partitions or hung ceilings, in crawl spaces, in shafts.
 8. Exposed: Not concealed.
 9. Underground: Buried within earth, more than 5'0" exterior to building foundations.
 10. Underslab: Buried within earth, interior to building foundations.
 11. Listed: Equipment is "listed" if of a kind mentioned in a list which:
 - a. Is published by a nationally recognized laboratory which makes periodic inspection of the production of such equipment.
 - b. States that such equipment meets nationally recognized standards or has been tested and found safe for use in a specified manner.
 12. Labeled: Equipment is "labeled" if:
 - a. It embodies a valid label, symbol, or other identifying mark of a nationally recognized testing laboratory such as Underwriters' Laboratories, Inc.
 - b. The laboratory makes periodic inspections of the production of such equipment.
 - c. The labeling indicates compliance with nationally recognized standards or tests to determine safe use in a specified manner.
 13. Certified: Equipment is "certified" if:
 - a. Equipment has been tested and found by a nationally recognized testing laboratory to meet nationally recognized standards or to be safe for use in a specified manner.
 - b. Production is periodically inspected by a nationally recognized testing laboratory.
 - c. It bears a label, tag, or other record of certification.
 14. Inmate Accessible Areas: Areas within the prison project, at and below ten-feet above adjacent floor or grade, except as specifically exempted below, in other specification Sections, or by Owner's Representative.
 15. Relocate: Remove and reinstall equipment, or field device to another location. Conduit and wiring shall be extended to the new location.
 16. Demolished: Existing to be removed from the project site and disposed, including all associated disconnects, conduit, wiring, relays, switches, and associated equipment.
 17. Salvage: Remove and turn over to the Owner.
 18. Line Voltage: For the purposes of Division 28, line voltage is defined as circuits operating at 120 volts nominal or greater.
 19. Manufacturer's Representative: Individual certified, in writing, by the equipment manufacturer to be knowledgeable and thoroughly familiar with the installation, programming (if required), testing and troubleshooting of the specific equipment and system configuration

- installed. If the individual is one other than an employee of the equipment manufacturer, then written certificates proving manufacturer certification must be provided.
20. Nationally recognized testing laboratory: A testing laboratory which is approved, in accordance with OSHA regulations, by the Secretary of Labor.
 21. Point-To-Point Wiring Data or Point-To-Point Wiring Diagram: Wiring diagrams representing the physical wiring of a the low voltage systems including:
 - a. How each device is physically connected to headend equipment;
 - b. Showing terminal designations of used and unused terminals;
 - c. Showing physical layout of all cabinets, enclosures, terminal boards, relays, and power supplies;
 - d. Showing the terminal designations, wiring designations, and wire tags/colors.
 22. Software Binder: Physical 3-ring binder with pockets including all software, licenses, and source code used for systems specified under this Division.
- B. The following specification development organizations are referenced throughout the various specification sections of Division 28:
1. ADAAG - Americans with Disabilities Act Accessibility Guidelines.
 2. ANSI - American National Standards Institute.
 3. CEC - California Electrical Code.
 4. CMC - California Mechanical Code.
 5. EIA - Electronic Industries Association.
 6. FCC - Federal Communications Commission.
 7. FM - Factory Mutual.
 8. NEMA - National Electrical Manufacturer's Association.
 9. NETA - International Electrical Testing Association.
 10. NFPA - National Fire Protection Association.
 11. NIST - National Institute of Standards and Technology.
 12. UL - Underwriters Laboratories, Inc.

1.7 OMISSIONS

- A. No later than ten (10) days before bid opening, the Contractor shall call the attention of the Owner's Representative to any materials or apparatus the Contractor believes to be inadequate and to any necessary items of work omitted.

1.8 PROJECT/SITE CONDITIONS

- A. Install Work in locations shown on Drawings, unless prevented by Project conditions.
- B. Prepare drawings showing proposed rearrangement of Work to meet Project conditions, including changes to Work specified in other Sections. Obtain permission of the Owner's Representative before proceeding.
- C. Tools, materials and equipment shall be confined to areas designated by the Owner's Representative and user agency.

1.9 WORK SEQUENCE AND SCHEDULING

- A. Install work in phases to accommodate user agency's occupancy requirements. During the construction period coordinate low voltage electronics schedule and operations with the Owner's Representatives:
- B. See the General Conditions of the Contract, Scheduling and Coordination of Work and Time for completion of the project, and General Requirements for additional requirements.

1.10 WORK BY OTHER TRADES

- A. Every attempt has been made to indicate in this trade's specifications and drawings all work required of this Contractor. However, there may be additional specific paragraphs in other trade specifications and addenda, and additional notes on drawings for other trades which pertain to this Trade's work, and thus those additional requirements are hereby made a part of these specifications and drawings.
- B. Low voltage electronics details on drawings for equipment to be provided by others is based on preliminary design data only. This Contractor shall lay out the low voltage electronics work and shall be responsible for its correctness to match equipment actually provided by others.

1.11 CONTRACT DRAWINGS

- A. The contract drawings indicate the extent of low voltage electronics work and the approximate locations and arrangement of the low voltage equipment and devices.
 - 1. The drawings do not necessarily show the exact number of raceways, junction boxes, or outlet boxes for the circuits required, nor does it show the exact routing of the circuits and conduit. The contractor shall field verify routing requirements and coordinate those requirements with other trades as indicated in the paragraph titled COORDINATION.
 - 2. The drawings do not necessarily show the exact number of equipment modules, power supplies, terminal strips, relays, patch panels, network switches, or equipment for the systems indicated, nor does it show the exact placement of equipment on the project. The contractor shall verify all equipment configuration requirements and coordinate those requirements within the spaces indicated on the drawings.
 - 3. The contractor shall provide all raceways, boxes, conductors, connections, supports, and all other materials required for the low voltage systems shown or noted in the contract documents to be complete and fully operational upon completion of the project.
- B. The specifications and drawings are complimentary and what is required in either is as binding as if indicated on both. Where a conflict or discrepancy exists between the drawings and the specifications, the most stringent shall apply.

1.12 RECORD DRAWINGS

- A. The Contractor shall maintain at least one copy each of the specifications and drawings on the job site at all times.
- B. See Division 01 for additional requirements.
- C. The Owner will provide the Contractor with a suitable set of contract drawings on which daily records of changes and deviations from contract shall be recorded.

All buried or concealed piping, conduit, or similar items shall be located by dimensions and elevations on the record drawings.

- D. The daily record of changes shall be the responsibility of Contractor's field superintendent. No arbitrary mark-ups will be permitted.
- E. Present the job copy showing variations and changes to date to the Owner's Representative at Construction Progress meetings.
- F. At completion of the project, the Contractor shall submit the marked-up record drawings to the Owner's Representative prior to final payment. See Section 01 77 00 Closeout Procedures and 01 78 00 Closeout Submittals.

1.13 WARRANTY

- A. The Contractor shall warrant the installation to be free from defects in materials and workmanship for a period of one year from Date of Substantial Completion.
- B. During the warranty period, all service (including equipment, labor, travel, expenses, etc.) is to be provided during normal working hours at no cost to the Owner. On-site service must also be made available at times other than normal working hours to the Owner and shall be charged by the integrator's service representatives at current rates of labor and travel. The integrator shall provide the Owner with a manned, 24-hour phone number for service. The integrator shall provide the Owner a phone response within 4 business hours of receipt of service call. The integrator shall provide an on-site response time of one business day for system critical items during regular business hours. "Critical" items are items which compromise the overall security of the facility. Critical item components shall include PLC system components, touch screen control stations, video matrix switching equipment, perimeter detection equipment, officer duress equipment, intercom head-end equipment and uninterruptible power supplies.

1.14 MAINTENANCE SERVICE

- A. A minimum of 60 days prior to the expiration of the warranty, the integrator shall provide a proposal to Owner to provide service and maintenance of the low voltage system installation on a yearly basis. The Owner will be under no obligation to accept the maintenance service proposal.

1.15 MAINTENANCE MATERIALS

- A. Provide maintenance materials under provisions of Section 01 78 23 – Operation and Maintenance Data.
- B. Provide items as identified in each individual specifications section.

PART 2 - PRODUCTS

2.1 APPROVED ELECTRICAL TESTING LABORATORIES

- A. The following laboratories are approved for providing electrical product safety testing and listing services as required in these specifications:
 - 1. Underwriters Laboratories Inc.
 - 2. Electrical Testing Laboratories, Inc.

2.2 REQUIRED MEETINGS

- A. The following meetings between the Contractor and the Owner's Representative are required during this project:
1. System Architecture Pre-Development Meeting: The Contractor shall provide a system architecture pre-development meeting to discuss network architecture for the PLC/Touchscreen (GUI) system, the CCTV system, the Intercom/Paging system, and the Access Control system. Additionally, the interface requirements of the existing fire alarm system to the new system shall be discussed.
 - a. Location: Online.
 2. Systems Operational Meeting #1: The Contractor shall provide an initial meeting to discuss the operational requirements for the following systems shall be discussed:
 - a. PLC/Touchscreen Control System. Discuss touchscreen (GUI) screen layouts and arrangement, icon representation, audio alarming, and system operation. Discuss fail-over responsibility.
 - 1) The Contractor shall provide an operational Touchscreen Control System demonstration unit consisting of a workstation and/or laptop with a touchscreen, minimize size of 23", during the meeting to discuss operation and layout of the touchscreen graphics.
 - b. CCTV System. Discuss video call-up, cycling of cameras ,areas to be constantly viewed, and which images are displayed at which workstation.
 - c. Intercom/Paging System. Discuss intercom and paging priorities, paging precedence, and intercom roll-over.
 - d. Access Control System. Discuss user groups and access rights for each controlled door.
 - e. Duress Alarm System.
 - f. Location: At the project site and Online.
 3. Systems Operational Meeting #2: Based on input from the first meeting, the Contractor shall review the systems discussed in the first meeting and provide an updated operational review of all systems.
 - a. Location: At the Project Site and Online.
 4. Reference 'Testing and Verification' for additional meetings, in-shop factory testing, and installation testing.
- B. Online meetings shall utilize an online meeting service such as GoToMeeting, WebEx, or similar. The Contractor shall be responsible for setting up, paying for, and inviting attendees for all online meetings.

2.3 SUBMITTALS

- A. General:
1. Partial submittals are not acceptable, and will be considered non-responsive, and will be returned without review.
 2. Submittals not required by the Agreement Documents may not be reviewed and may be discarded.
 3. The contractor may use the contract documents as a basis for all submittals and shop drawings. Electronic copies of all Division 28 drawings and schedules will be made available to the contractor in

AutoCAD and Microsoft Excel format, free of charge, for contractor use. Provide a written statement to the Engineer along with a list of the requested documents and schedules as well as a requested means of delivery (CD-ROM, e-mail).

4. Review comments shall not relieve Contractor from responsibility for deviations from Contract Documents unless attention has been called to such deviations in writing at time of submission, nor shall they relieve this Contractor from responsibility for errors in items submitted.

B. Substitutions/Prior Submittals

1. Items specified are intended to represent quality and general requirements. It is not the intent of these specifications to prohibit other manufacturers from submitting on substitute materials for review as an acceptable equal. Substitution requests must be submitted in accordance with Section 01 60 00 Substitution Procedures at least seven (7) days prior to the bid. If prior approval has not been requested and granted, then the product manufacturer shall be as noted on the contract documents. The Owner's Representative reserves the right to reject any product that has not been prior approved. It is the Contractor's responsibility to request prior approval, or else provide the product as specified. The Contractor shall be responsible for checking equipment dimensions of proposed substitute equipment and be responsible for its fitting the space allowed. Approval of submittals for products other than those specified is granted with the understanding that any additional cost involved with the installation or performance of the substitute product required to conform with the building design and/or specifications shall be paid for by the Contractor. The cost of any redesigning caused by a substitution shall be borne by the Contractor.
2. Substitution after the bid will only be allowed for any one of the following reasons:
 - a. The substitute product is approved as a better product by the Owner's Representative, at no increased cost.
 - b. The substitute product is approved as an equal by the Owner's Representative and a credit is offered to the Owner. Reference Division ~1 documents for substitution request procedures.
 - c. The reason for unavailability is discontinuance by manufacturer.

C. Submittals for Approval:

1. Schedule of Values: Within 30 days after Notice to Proceed, the successful bidder shall furnish a low voltage cost breakdown of each low voltage specifications section broken into materials and labor. Include the following in the cost breakdown: See also Section 01 29 00 Payment Procedures.
 - a. Bonds.
 - b. Permits and Fees.
 - c. Cartage, Rentals, Shack.
 - d. Supervision.
 - e. Electrical Warranty.
 - f. Equipment Enclosures.
 - g. Low Voltage Security Conduit.

- h. Low Voltage Wire and Cable.
 - i. Low Voltage Devices.
 - j. Grounding and Bonding.
 - k. Supporting Devices.
 - l. Low Voltage Identification.
 - m. Programmable Logic Controller System. Include any necessary programming as a separate line item.
 - n. Access Control Systems. Include any necessary programming as a separate line item.
 - o. Touchscreen Control Systems. Include any necessary programming as a separate line item.
 - p. Intercom and Paging Systems. Include any necessary programming as a separate line item.
 - q. Closed Circuit Television Systems. Include any necessary programming as a separate line item.
 - r. Uninterruptible Power Supplies. Include any necessary programming as a separate line item.
 - s. Network Equipment.
2. Provide product data sheet(s) for each type of product specified within Division 28 of these specifications. Data sheets showing multiple products or models shall be clearly marked identifying the specific product or model being proposed. Provide original data sheets only. Fax copies are not acceptable. Product data sheets shall include the specification section that the product is located in at the top of each data sheet.
- a. Product data sheets shall be provided in Adobe Acrobat, pdf format, latest version and shall be provided on CD, DVD, via email, or via secure ftp site.
3. Submit the above required information for all equipment and systems as indicated above and in the respective specification sections, marking each submittal with that specification section number. Mark general catalog sheets and drawings to indicate specific items being submitted and proper identification of equipment by name and/or number, as indicated in the contract documents. Failure to do this may result in the submittal(s) being returned to the Contractor for correction and resubmission. Failing to follow these instructions does not relieve the Contractor from the requirement of meeting the project schedule.
4. Shop drawings, detailing the security electronics system including but not limited to the following:
- a. All drawings shall be drawn to scale that detail racks, enclosures, and/or field devices. All devices shall be shown.
 - b. All shop drawings generated for this project shall be created utilizing AutoCAD 2017 or greater file format.
 - 1) Drawings shall be submitted on sheet sizes the same size as the contract documents.
 - 2) Text sizes shall be 3/32" minimum at 1/8"=1'0" scale.
 - 3) Text shall not be rotated on the drawings.

- c. Drawings shall be provided for each field device detailing wiring and mounting instructions.
- d. Point-to-point wiring data shall be provided, utilizing a combination of AutoCAD generated drawings and security control point schedules. The schedules shall be created with Microsoft Excel and shall cross-reference AutoCAD drawings as required. Schedules shall detail all equipment being provided and controlled/monitored by the security electronics system. The schedules shall be organized according to different system functionality. Typical schedules shall include, but not be limited to, sections for cabling information, control locations, door hardware interface, intercom, paging, cameras, CCTV monitors, access control, duress, video visitation, etc. The drawings and schedules shall indicate the wiring of components and all connections to be made. Terminal connections in the equipment shall be numbered to correspond to drawings and schedules for use in making connections. All schedules shall be included with the product data sheets in three ring binders as previously described.
- e. Provide a system and network architecture drawing showing the following:
 - 1) Physical network topology for each networked system.
 - 2) Software architecture for each networked system.
 - 3) System software physical locations for each networked system (i.e. indicate software, modules, add-ons and version of software running on each Touchscreen (GUI) workstation and I/O server.).
 - 4) Submit the above information 14 days prior to the System Architecture Pre-Development Meeting.
- f. Drawings for the PLC configuration shall include model numbers of each component used and all required switch settings for proper operation and configuration of the system.
- g. Provide all Touchscreen (GUI) graphical layouts. Reference Section 28 46 23 - Touchscreen Control System for additional requirements. Submit the required information 14 days prior to the Touchscreen (GUI) Operational Meeting.
- h. Provide floor plan drawings to include the following:
 - 1) Layout of all field devices including device naming and/or tag naming. Minimum scale 1/8"=1'0"
 - 2) Conduit/raceway layout between all field devices to headend equipment. Identify if conduit will be routed below slab, or routed overhead. Minimum scale 1/8"=1'0"
 - 3) Conduit/raceway layout between all headend equipment, and between headend equipment and control panel locations. Minimum scale 1/8"=1'0"
 - 4) Control room layouts showing dimensioned arrangement of all control equipment with cabinetry to be provided under other Sections, and all power, data and system interconnect outlets. Minimum scale 1/4"=1'0".

- 5) Equipment room layouts showing dimensioned arrangement of all equipment, conduit/raceway, outlets, power panels, UPS equipment, and grounding equipment. Minimum scale 1/4"=1'0".
 - i. Drawings of equipment cabinet(s) or racks shall detail the arrangement of all components installed.
 - j. Provide power distribution and power loading detail drawings.
 - 1) Power distribution calculations shall be done in accordance with the latest version of the NEC and shall include the load categories and demand factors required by the NEC.
 - 2) Power system distribution calculations and design spreadsheet shall show power loading for all DC power supply circuits, AC emergency circuits, AC UPS circuits, and AC normal power circuits required by the Low Voltage System. The spreadsheet shall consist of each circuit, each device controlled by the Low Voltage System with each device's steady state and in-rush load, and a loading summary of all device types for each circuit. This design requires coordination with other subcontractors who provide such equipment as (but not limited to) the door locks, lighting circuits, water solenoids, and any other device controlled by the Low Voltage System.
 - k. Provide overall Security Electronics System Riser, Intercom Riser, Ethernet Riser, CCTV Riser, and PLC System Riser diagrams. Drawings shall include all interconnecting wiring, cable types and sizing. Provide manufacturers wire type where required.
 5. Provide wiring diagrams, detailing wiring for power, signal and control, differentiating clearly between manufacturers installed wiring and field installed wiring. Identify terminals to facilitate installation, operation, and maintenance.
 6. On request from the Owner's Representative, the successful bidder shall furnish additional drawings, illustrations, catalog data, performance characteristics, etc.
 7. Submittals shall be grouped to include complete submittals of related systems, products, and accessories in a single submittal. Mark dimensions and values in units to match those specified. Include wiring diagrams of electrically powered equipment.
 8. The above submittals must be approved before fabrication or installation is authorized.
 9. Refer to individual specification sections for additional information required to be incorporated into the Submittals for Approval.
- D. Factory Test Submittals:
1. Submit sample forms for approval for use in the Contractor's in-shop Pre-Functional Test testing.
 2. Submit a complete copy of the Contractor's in-shop Pre-Functional Test for review and approval a minimum of two weeks prior to the Owner's Representative witnessing the in-shop Factory Test.
 3. Submit results of each Factory Test utilizing approved form.

- E. Submittals for Close-out Submittals and As-Built Documentation:
1. Include electronic files in both .pdf and .dwg or .dxf format for the following items:
 - a. Shop Drawings. Shop drawings shall be updated to conform to actual installation.
 - 1) Point-to-point diagrams, wiring diagrams, and construction details for all built-up equipment.
 - 2) A complete list of PLC input and output points referencing each field device being controlled and/or monitored.
 - 3) Rack elevations.
 - 4) Provide all Touchscreen (GUI) graphical layouts at 1:1 scale.
 - 5) Provide a screenshot of each CCTV camera field of view after final Owner acceptance.
 - b. Record Drawings.
 2. Network addressing: All IP based equipment shall be scheduled to include the following:
 - a. Switch designation;
 - b. Switch port number;
 - c. Device number;
 - d. IP address;
 - e. Network subnet mask;
 - f. MAC address.
 - g. Network addressing shall be included in either the Shop Drawings or the Operating and Maintenance Manuals.
 3. Operating and Maintenance Manuals
 - a. See Division 1, GENERAL REQUIREMENTS - Operating and Maintenance Instructions for additional requirements.
 - b. Assemble material in three-ring or post binders, using an index at the front of each volume and tabs for each system or type of equipment. In addition to the data indicated in the General Requirements, include the following information:
 - 1) Copies of all approved submittals.
 - 2) Manufacturer's wiring diagrams for electrically powered equipment.
 - 3) Installation and operating instructions.
 - 4) Records of tests performed to certify compliance with system requirements.
 - 5) Certificates of inspection by regulatory agencies.
 - 6) Parts lists for manufactured equipment.
 - 7) Preventive maintenance recommendations and servicing data.
 - 8) Copies of all component warranties and installation warranties.

- 9) Additional information as indicated in the technical specification sections.
 - 10) Emergency instructions for operational and maintenance requirements.
- c. Provide a “software binder” to the Owner upon final system turnover.
- 1) This software binder shall consist of a three ring, hard cover binder that shall include at a minimum, the following items; all computer manufacturer’s backup/recovery discs, touch screen overlay software driver disc, software drivers for peripheral equipment (i.e. printers), touch screen configuration software licenses, CCTV software, and digital intercom administrator software (if provided).
 - 2) The software binder shall include all source codes and licenses for each system included within these specifications.
 - 3) The software binder shall also include a licensed copy of a PC hard drive cloning software equal to Norton Ghost™. Provide one DVD clone copy of each touch screen control station computer and Security Management Server computer (if shown) in the system.
 - 4) Original passwords (provided at time of final completion) provided to access devices such as CCTV keyboards, Security Management Server, touch screen control stations, digital video recording client software, etc., shall be provided in document format.
 - 5) Turn over to owner all termination point and interconnection schedules, all programming source codes including Touch Screen software, PLC development software, Camera recording software, Camera viewing software, and applicable licenses required for operations, maintenance and changes. This is to also include the touch screen and security management system runtime licenses.
 - 6) Provide one complete software development package including license (issued to the owner). Include all other independent development licenses such as but not limited to CCTV, audio, card access and PLC systems utilized on the project. Provide software programming instruction to the owners designated representative. Programming instruction shall include a detailed explanation of how to create I/O and memory tags, icon creation, event logging, create and edit scripts, PLC modifications, independent system programming methods (CCTV, audio, card access system, PLC) for all systems on the project.
- d. Reference individual Specification Sections for additional requirements.

PART 3 - EXECUTION

3.1 ELECTRONIC SOFTWARE STANDARDS

- A. Design and drawing software for Shop Drawings, Record Drawings, etc shall be the following:
 - 1. Computer Aided Design (CAD): AutoCAD, 2020.
 - 2. Building Information Modeling (BIM): Revit, 2020.
 - 3. Graphic Conventions for Text and Notes: The minimum text size shall be 3/32" (2.5mm).

3.2 INSTALLATION OF LOW VOLTAGE ELECTRONICS SYSTEMS

- A. Electronic equipment installed in control rooms and low voltage electronics rooms shall not be installed until after the environment is free of all dust. A dust free environment shall be defined as follows:
 - 1. All concrete, gypsum wallboard, and tile cutting and patching is complete or other dust producing construction operation is complete.
 - 2. All fireproofing is complete.
 - 3. All painting is complete.
 - 4. All ceiling materials are installed.
 - 5. All air handling systems serving these areas have been in operation for at least one week, and the filters have been changed at least once prior to electronics equipment installation.
- B. All cabling for systems indicated in these specifications shall be installed in conduit, unless indicated otherwise elsewhere within these specifications.

3.3 CONTINUITY OF EXISTING SERVICES AND SYSTEMS

- A. No outages shall be permitted on existing systems except at the time and during the interval specified by the user agency and by the Owner's Representative. The Owner will require written approval. Any outage must be scheduled when the interruption causes the least interference with normal schedules and business routines. No extra costs will be paid to the Contractor for such outages which must occur outside of regular weekly working hours. Written approval must be requested a minimum of 14 days in advance of the scheduled outage.
- B. Any circuit interrupted as a result of this work shall be restored to proper operation by this Contractor as soon as possible. Note that institutional operations are on a seven day week schedule.

3.4 PROTECTION OF FINISHED SURFACES

- A. See Division 1, GENERAL REQUIREMENTS - Protection of Finished Construction for additional requirements.
- B. Furnish one can of touch-up paint for each different color factory finish which is to be the final finished surface of each product furnished by the Contractor. Deliver touch-up paint with other maintenance and replacement material.

3.5 CUTTING AND PATCHING

- A. Refer to Division 01 for additional requirements.
- B. Cutting of concrete or other building materials shall be avoided where possible. The Contractor shall have a workman present at the pouring of concrete and at the building of any masonry that contains electrical work.

- C. All cutting and patching of new and existing construction required for the installation of systems and equipment specified in Division 26 shall be the responsibility of the Division 26 Contractor. All cutting shall be accomplished with masonry saws, drills or similar equipment to provide neat uniform openings.
- D. Patch and repair walls, floors, ceilings and roof with materials of same quality and appearance as adjacent surfaces unless otherwise shown. Surface finishes shall exactly match existing finishes of same materials. All patching shall meet the approval of the Owner's Representative.
- E. All cutting and patching made necessary to repair defective equipment, defective workmanship or by neglect of this Contractor to properly anticipate his requirements shall be included in this Contract.
- F. Cut carefully to minimize necessity for repairs to existing work. Do not cut beams, columns, or trusses or other structural members without the Owner Representative's written approval.
- G. Cutting, patching, repairing, and replacing pavement, sidewalks, roads, and curbs to permit installation of work specified or indicated under this Division is included in this Contract.
- H. Penetrations of Existing Fire Rated Assemblies:
 - 1. Prior to starting construction, the Contractor must obtain a permit from Consolidated Support Services (CSS) in accordance with CSS C-41 Work Directive. Reference Section 01 35 10 Special Procedures and form attached at the end of that section.

3.6 BUILDING ACCESS

- A. Institutional Facilities: When working in institutional facilities escorts are required in all areas of the facility. Reference Section 01 14 00 Work Restrictions.
- B. Arrange for the necessary openings in the building to allow for admittance of all apparatus. When the building access was not previously arranged and must be provided by this contractor, restore any opening to its original condition after the apparatus has been brought into the building.

3.7 EQUIPMENT ACCESS

- A. Install all piping, conduit, ductwork, panels, and accessories to permit access to equipment for maintenance. Coordinate the exact location of wall and ceiling access panels and doors with the General Contractor, making sure that access is available for all equipment and specialties. Where access is required in plaster or drywall walls or ceilings, furnish the access doors to the General Contractor and reimburse the General Contractor for installation of those access doors.
- B. Working Clearances: Minimum installed equipment working clearances as required by the CEC Table 110-34(a) shall be used. The clearances shall be based on phase-to-phase voltage and condition 3 of that table. As a minimum, there shall be 3 feet of clearance in front of all panels and enclosures.

3.8 COORDINATION

- A. The Contractor shall cooperate with other trades and the Owner's Representative in locating work in a proper manner. Should it be necessary to raise or lower or move longitudinally any part of the low voltage work to better fit the general

installation, such work shall be done at no extra cost to the Owner, provided such decision is reached prior to actual installation. The Contractor shall check location of low voltage devices with respect to other installations before installing.

- B. The Contractor shall verify that all devices are compatible for the surfaces on which they will be used. This includes, but is not limited to, fire alarm devices, intercom stations, speakers, panels and enclosures, pushbuttons, card readers, etc.
- C. Coordinate all work with other contractors prior to installation. Any installed work that is not coordinated and that interferes with other contractor's work shall be removed or relocated at the installing contractor's expense.

3.9 TRAINING OF USER AGENCY'S PERSONNEL

- A. Instruct user agency's personnel in the proper operation of systems and equipment provided as part of this project; video tape all training sessions and provide two (2) digital video disks of all training. Include not less than forty (40) hours of instruction. Demonstrate startup and shutdown procedures for all equipment. All training to be during normal working hours.
- B. Instruct user agency's personnel in the proper maintenance of systems and equipment provided as part of this project; video tape all training sessions and provide two (2) digital video disks of all training. Include not less than forty (40) hours of instruction, using the Operating and Maintenance manuals during this instruction. Demonstrate startup and shutdown procedures for all equipment. All training to be during normal working hours.

3.10 HOUSEKEEPING AND CLEAN UP

- A. See Division 1, GENERAL REQUIREMENTS - Cleaning for additional requirements.
 - 1. The Contractor shall clean up and remove from the premises, on a daily basis, all debris and rubbish resulting from its work and shall repair all damage to new and existing equipment resulting from its work. When job is complete, this Contractor shall remove all tools, excess material and equipment, etc., from the site.

3.11 TESTING AND VERIFICATION

- A. Verification by Test and Demonstration: The Contractor shall verify by demonstrations or tests that the requirements of this Specification have been met. All demonstrations and testing shall be witnessed by the Owner's Representative.
- B. The Owner's Representative shall be notified in writing at least fourteen days in advance of all testing. Should the Owner's Representative be unable to attend, the testing shall be re-scheduled at the convenience of both the Contractor and the Owner's Representative.
- C. In-Shop Testing: The Contractor shall provide testing of all equipment assembled in shop prior to delivery to the project site. All shop assembled equipment shall not be delivered to the project site without an in-shop Factory Test, witnessed by the Owner's Representative.
 - 1. Prior to the in-shop Factory Test, the Contractor shall perform a complete Pre-Functional Test to ensure all devices and functions listed

below are fully operational prior to the Owner's Representative witnessing the in-shop Factory Test. The Contractor shall submit a sample Pre-Functional Test form for approval, and two weeks prior the Owner's Representative witnessing the in-shop Factory Test, the Contractor shall submit the complete results of the Pre-Functional Test for approval.

2. The in-shop Factory Test shall be witnessed by the Owner's Representative, shall demonstrate that the following items operate in accordance with the Contract Documents:
 - a. Following in-shop assembly and Contractor testing, the Contractor shall perform the following tests, prior to shipping equipment to the site, in the presence of the Owner's representative to ensure operation in accordance with the contract documents:
 - b. Test of all central CPUs, workstations, peripherals, and all panel control functions.
 - c. Test of all hardwired control panels.
 - d. Test electrical supervision of all input/output sensor and data communication bus circuits.
 - e. Test of all alarm initiating devices and door control operations.
 - 1) Provide a minimum of one type of each type of door alarming and control device to verify system operation. The Contractor shall reconnect the necessary devices to simulate field conditions of each and every system input and output.
 - f. Test of closed circuit television system components, cameras, switchers, and monitors. Each and every camera shall be set up, powered, and connected to the CCTV system to verify operation for the in-shop Factory Test.
 - g. Test of access control system to include tie-in to all related systems.
 - 1) Provide a minimum of one type of each type of access control device to verify system operation. The Contractor shall reconnect the necessary devices to simulate field conditions of each and every system input and output.
 - h. Visual inspection of all wiring.
 - i. Test of all intercommunications and paging system components including amplifiers, staff stations, administrative stations, call stations, and wiring system.
 - 1) Provide a minimum of one type of each type of intercom and paging device to verify system operation. The Contractor shall reconnect the necessary devices to simulate field conditions of each and every system input and output.
 - 2) Where IP connected devices are indicated on the drawings and/or within the specifications, the Contractor shall set up each and every IP connected device for the in-shop Factory Test.

- j. Demonstrate software, alarm, control, and display functions of all microprocessor systems.
 - k. Verification of systems response time.
 - l. Demonstrate all rack mounted UPS systems.
 - m. Demonstrate all network communications systems.
 - n. Any deficiencies shall be corrected by the Contractor, and the corrective action witnessed by the Owner's Representative, prior to shipment of the equipment to the project site. Note: this requirement may result in multiple demonstrations to the Owner's Representative.
3. The travel costs for the Owner's Representative to witness the above in-shop tests shall be included within the Contractor's bid. This shall include airfare, car rental, per diem, and overnight lodging costs which shall be billed by the Owner's Representative to the Contractor at 1.1 times actual costs. Additionally, the Contractor will be billed for subsequent tests after the first test at a rate of \$3200 per day.
- D. Field Testing and Commissioning: Following installation and on-site Contractor testing, the Contractor shall perform the following tests, after installation and prior to Substantial Completion, in the presence of the Owner's Representative to ensure operation in accordance with the contract documents:
1. Test of all central CPUs, workstations, peripherals, and all panel control functions.
 2. Test electrical supervision of all input/output sensor and data communication bus circuits.
 3. Test of all alarm initiating devices and door control operations.
 4. Test of closed circuit television system components, cameras, switchers, and monitors.
 5. Test of access control system to include tie-in to all related systems.
 6. Visual inspection of all wiring.
 7. Test of all intercommunications and paging system components including amplifiers, staff stations, administrative stations, call stations, and wiring system.
 8. Test of battery and battery chargers.
 9. Complete operation tests under emergency power, including switchover from normal to emergency power.
 10. Demonstrate software, alarm, control, and display functions of all microprocessor systems.
 11. Demonstrate and test system network failure modes.
 12. Verification of systems response time.
 13. The above testing will require additional time as the Owner's Representative will test all control functions first from the Control Room or control point, and then test all field devices.
- E. In the event that the Architect and/or Engineer are required to witness a retest at a later date because the Contractor is not adequately prepared to conduct the acceptance tests or because the systems being tested have failed such tests, which shall be solely determined by the Architect, the costs of witnessing additional tests (based on time and materials at the established rates of the Architect and Engineer) shall be borne exclusively by the Contractor. In such an event, a change order to the General Construction Contract will be executed for compensation of the Architect and Engineer witnessing the tests.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Applicable provisions of Division 01 shall govern all work under this Section.
- B. Section Includes:
 - 1. Equipment enclosures.
 - 2. Equipment Racks.
 - 3. Relays.
 - 4. Terminal Strips.
 - 5. Power Supplies.
 - 6. Electrical Boxes.
 - 7. Access Panels and Doors.
 - 8. Accessories.
- C. Related Sections:
 - 1. The General Low Voltage Requirements, Section 28 00 00, are part of this Section, and the contract for this work, and apply to this Section as fully as if repeated herein.
 - 2. Section 28 46 3 - Network Equipment.

1.2 SUBMITTALS

- A. Submit product data under provisions of Section 28 00 00 and Division 01.
- B. Submittals for Approval:
 - 1. Include dimensioned shop drawings and wiring diagrams.
 - a. Provide detailed shop drawings for each low voltage security electronics room or equipment room with low voltage security electronics equipment. Shop drawings shall include:
 - 1) Equipment racks, equipment enclosures, control cabinets, floor mounted equipment, and wall mounted equipment.
 - 2) Electrical panels (Section 26 24 16), and UPS and Maintenance ByPass Switches (Section 28 50 00).
 - 3) All conduit (Section 28 05 28) and surface raceways (Section 28 05 35).
 - b. Provide dimensioned elevations for all equipment racks:
 - 1) Include front and rear elevations of all equipment racks detailing each rack space.
 - 2) Include dimensioned backplane layouts for all relays, power supplies, terminal blocks, Class 1 and Class 2 wireways, and other related equipment.
 - 3) Show separations between incoming 120VAC, Class 1, and Class 2 wiring.

- c. Provide dimensioned elevations for all wall mounted equipment enclosures:
 - 1) Include dimensioned backplane layouts for all relays, power supplies, terminal blocks, Class 1 and Class 2 wireways, and other related equipment.
 - 2. Product Data: Provide dimensions, ratings, performance data, weights and accessory information for each type.
- C. Submittals for Close-Out:
- 1. Product Data: Provide updated information for all Product Data.
 - 2. As-Built Drawings: Provide final configuration of equipment enclosures including all field modifications.

1.3 REGULATORY REQUIREMENTS

- A. Equipment enclosures and racks shall be assembled of UL listed materials.
- B. Custom fabricated enclosures shall be assembled by a UL 508 certified shop.

1.4 EXTRA MATERIALS

- A. Provide maintenance materials under provisions of Section 01 78 00 – Closeout Submittals.
- B. Provide 10% of each type relay and power supply used with a minimum of one (1) of each type listed in Part 2.

PART 2 - PRODUCTS

2.1 EQUIPMENT ENCLOSURES

- A. Relay Enclosure Cabinets:
 - 1. Construction: 14 gauge steel, with integral door and body stiffeners. Interior back panel shall be removable. Provide locking, single point latch kits on all panels.
 - 2. Grounding: Provide grounding straps for electrical continuity between metal parts. Minimum size shall be #4.
 - 3. Finish: ANSI 61 gray polyester powder coating over phosphatized surfaces. Interior back panels shall be white enamel.
 - 4. Doors shall single door or twin door as shown on the drawings.
 - 5. Cabinets shall be equal to Hoffman #A-48N3611.
- B. Hinged Cover Enclosures:
 - 1. Construction: General Purpose Enclosure, steel
 - 2. Finish: Manufacturer's standard enamel finish.
 - 3. Covers: Twin door, continuous hinge, held closed by flush latch operable by key.
 - 4. Back Panel: 14 gauge steel, white enamel finish; for mounting terminal blocks and electrical components.

C. Cabinets

1. Cabinet Boxes: Galvanized steel with removable endwalls, 2-3/8 inch wide, height as required, 6 inch deep. Provide 3/4 inch thick plywood backboard painted matte white, for mounting terminal blocks.
2. Cabinet Fronts: Steel, flush or surface type screw cover front, concealed hinge and flush lock keyed to match branch circuit panelboard; finish in gray baked enamel.

2.2 EQUIPMENT RACKS

A. Four (4) Post Equipment Racks:

1. Floor Mounted Full Height Racks:
 - a. Where shown on the drawings, provide 4-post, enclosed equipment rack to house intercom, CCTV, PLC, relay backplanes, and perimeter system equipment and maintenance workstations. The rack shall be a steel 19-inch (483 mm) rack, conforming to EIA Standard 310.
 - b. The rack shall be pre-drilled, with holes centered 0.5" (12.70 mm) apart in repeating pattern.
 - c. Racks shall be full-size free-standing self-squaring frames, with double sided rack space. Free-standing racks shall be equal to Chatsworth T-Series Steel Frame cabinets or equal as manufactured by Middle Atlantic Products, Winsted, or approved equal.
 - 1) Nominal dimensions shall be 78.00"H x 24"W x 31.5"D with 42 units of mounting space, each 1.75" (445 mm) high.
 - 2) Racks shall be Seismic certified (UBC 1997 & CBC 1998 Zone 4; IBC 2000, IBC 2003, ASCE 7 - 02, NFPA 5000 Seismic Use Group III) for protecting 1050 lbs. of essential equipment.
 - 3) Provide 14 ga steel top and bottom ventilated enclosures for each rack.
 - 4) Provide 16 ga steel side ventilated enclosures for each rack.
 - 5) Front and rear doors shall be key lockable.
 - 6) Racks shall be OSHPD approved for fixed equipment anchorage in California healthcare facilities.
 - 7) Provide fan kit as required for ventilation of equipment.
 - d. Provide power strips, number as required, for each equipment rack.
2. Wall Mounted Swing Racks: Where shown on the drawings, provide enclosed wall-mounted sectional equipment racks to house intercom, CCTV, PLC, relay backplanes, and perimeter system equipment and maintenance workstations. Sectional wall racks shall be a fully enclosed metal cabinet to secure rack mount equipment to a wall location. Racks shall be capable of being mounted for right or left hand hinge opening.

- a. Racks shall be 7 rack units (RU), 10RU, 12RU, 24RU or 35RU high opening for equipment mounting, as required for the installation.
 - b. Racks shall provide 15" deep center section with 19" wide EIA. Rack rails for mounting equipment. Racks shall conform to EIA Standard 310.
 - c. Racks shall include rear section suitable for mounting cabinet with left or right hand hinging.
 - d. Racks shall provide perforated top and bottom flanges on cabinet sides for heat dissipation.
 - e. Racks shall be 16-gauge welded metal frame with 12 gauge adjustable front rack rails.
 - f. Include front locking door capable of right or left hand mounting.
 - g. Include wire isolation holes located top and bottom of rear section.
 - h. Include internal wire raceway.
 - i. Grounding: Provide grounding straps for electrical continuity between metal parts. Minimum size shall be #4.
 - j. Finish: Manufacturer's standard black finish.
 - k. Provide power strips, number as required, for each equipment rack.
 - l. Racks shall be Hoffman AccessPlus II double hinged enclosures or equal as manufactured by Hubbell, Chatsworth, Middle Atlantic Products, Winsted, or approved equal.
- B. Each rack shall be equipped with grounding lugs.
 - C. Racks shall be seismically braced.
 - D. Racks shall be UL-listed.

2.3 SECURED WORKSTATION ENCLOSURES

- A. Provide floor mounted enclosure capable of enclosing touchscreen workstation with a solid, lockable front and back, and vented side panels. Provide grommeting as required for cable entry. Provide ventilation on top, bottom, sides, and back for workstation cooling. Provide forced air fan to maintain workstation within environment conditions as set forth by the manufacturer. Provide fan filters for each fan. Nominal dimensions shall be 24"Hx 21.5"Wx24.5"D. Enclosure shall be WS series with casters for floor mounting, as manufactured by Great Lakes Case and Cabinets, <https://www.werackyourworld.com/>, or approved equal.

2.4 ELECTRICAL BOXES

- A. Sheet Metal Outlet Boxes: Galvanized steel, with 3/8 in male fixture studs where required.
- B. Ceiling Mounted and Equipment Supporting Boxes: Rated for weight of equipment supported; include 3/8 inch male fixture studs where required.
- C. Concrete Ceiling Boxes: Concrete type.

- D. Cast Boxes: Cast ferroalloy, deep type, gasketed cover, threaded hubs.
- E. Pull and Junction Boxes: Galvanized steel.
- F. Cast Metal Boxes for Outdoor and Wet Location Installations: Flat flanged, surface mounted raintight junction box. Galvanized cast iron box and cover with ground flange, neoprene gasket, and stainless steel cover screws. UL listed raintight.
- G. Outlet, pull boxes and junction boxes shall be minimum 4 inch square by 2 1/8 inches deep for use with 1 inch conduit and smaller. On conduit systems using 1 1/4 inch conduit or larger, pull, outlet and junction boxes shall be sized per NEC but not less than 4 11/16 inch square. Where boxes are installed in masonry walls, provide masonry boxes 3 1/2 inches deep.
- H. For telecommunication, fiber optic, security, and other low voltage cable installations the boxes shall be a minimum of 4 11/16 inches square.
- I. Sheet metal boxes larger than 12 Inches (300 mm) in any dimension shall be hinged. Hinged enclosures shall conform to NEMA standards unless noted otherwise.
- J. Outlet boxes shall be sized in according to the conduit, end device and building construction. Allow sufficient wiring space to support the conductor media and transmission characteristics in accordance with CED, EIA/TIA.
- K. Wireways shall not be used in lieu of junction boxes.

2.5 RELAYS

- A. Control Relay, General: Plug in type, with minimum of 10 ampere contacts, single pole, and indicating LED.
 - 1. IDEC RR Series, with 10 ampere contacts.
- B. Door Control Relay: Plug in type, with minimum of 20 ampere contacts, single pole, and indicating LED.
 - 1. Potter and Brumfield KUHP Series, with 20 ampere contacts.
- C. Solid State Time Delay Relay: SSAC #TDML, TDBL or TDSL as required.
- D. Flashing Relay: SSAC #FS524.
- E. Diodes: Diodes shall be rated 1amperes with a 1000 volt PIV, except relay coil shorting diodes shall be rated 2 amperes with a 1000 volt PIV. Mount diodes in plug in bases.

2.6 TERMINAL STRIPS

- A. Power Terminals: Unit construction type, closed-back type, rated 600 volts.
 - 1. Tubular pressure screw connectors.
- B. Signal and Control Terminals: Modular construction type, channel mounted, rated 600 volts.
 - 1. Tubular pressure screw connectors.

2.7 POWER SUPPLIES

- A. Provide one 24VDC system for each control panel. System shall include the following:
 - 1. Provide two (2) power supplies per system. Power supplies shall be configured to indicate primary unit failure at the control panel.
 - 2. Power supply units shall be shielded and grounded, and UL listed.
 - 3. Power supplies shall be fully enclosed.
 - 4. Voltage regulation shall be +/- 3%.
 - 5. Minimum capacity of each power supply shall be 100VA. Power supplies shall be sized to energize and continuously operate all controls and indicators simultaneously and shall be internally protected against short circuits and overloads.
 - 6. Provide an external reset button.
- B. Power supply shall be UL listed.

2.8 SURGE AND LIGHTNING PROTECTION

- A. All surge protection devices shall have the lowest surge voltage rating per U.L. 1449 that is consistent with the line levels.
- B. All data, power and video signal cables entering the facility from a point exterior to the building shall be equipped with a silicon avalanche diode type of lightning protection.
- C. Protector shall be located at the first cabinet through which the cable or conductor passes upon entering the building.
- D. 120VAC surge protection shall be installed on each non-UPS or emergency circuit feeding security devices. Provide DIN-rail mountable surge protectors equal to Transtector cat. No. DR-120.
- E. Approved surge protection manufacturers; Northern Technologies, Transtector and Ditek.

2.9 FUSEHOLDERS

- A. All electric locks shall be individually fused using industrial grade fuse holder terminal blocks mounted on DIN rail. The fuse holder shall include blown fuse indicators for both DC and AC powered doors. Fuseholders shall be equal to Wago 2002-1811 Series.

2.10 ACCESS PANELS AND DOORS

- A. Lay-in Ceilings: Removable lay-in ceiling tiles in 2 x 2 foot or 2 x 4 foot configuration provided under Section 08 31 13 are sufficient; no additional access provisions are required unless specifically indicated.
- B. Concealed Spline Ceilings: Removable sections of ceiling tile held in position with metal slats or tabs compatible with the ceiling system used will be provided under Section 08 31 13.
- C. Metal Pan Ceilings: Removable sections of ceiling tile held in position by pressure fit will be provided under Section 08 31 13.

- D. Plaster Walls and Ceilings: 16 gauge frame with not less than a 20 gauge hinged door panel, prime coated steel for general applications, stainless steel for use in toilets, showers and similar wet areas, concealed hinges, screwdriver operated cam latch for general application, key lock for use in public areas, UL listed for use in fire rated partitions if required by the application. Use the largest size access opening possible, consistent with the space and the equipment needed service; minimum size is 18" by 24".
- E. Minimum sizes indicated above shall be increased to meet Code requirements.

2.11 ACCESSORIES

- A. Non-Metered Power Distribution Units (PDUs):
 - 1. 120V, 1.8KW, One (1) NEMA 5-15P Input, Thirteen (13) 5-15R Outputs, Rack Mount: Tripplite PDU1215, or equal as manufactured by Geist.
 - 2. 120V, 2.4KW, One (1) NEMA 5-20P Input, Thirteen (13) 5-15R Outputs, Rack Mount: Tripplite PDU1220, or equal as manufactured by Geist.
- B. Rackmount Power Strips: Middle Atlantic Products, Inc. #PD-920R-NS, or equal as manufactured by Tripp-Lite, with one front 5-20R outlet, eight rear 5-20R outlets, on/off switch, and rear 1P-20A circuit breaker.

PART 3 - EXECUTION

3.1 GENERAL

- A. All equipment shall be mounted in control consoles, cabinets, or enclosures so as to provide ready accessibility for equipment and termination. All cabinets and enclosures shall be located to provide working clearance in front of accessible equipment as required by the National Electrical Code.
- B. Provide grounding module in each control cabinet and secure to the building electrical system.
- C. Control Panel and Terminal Enclosure Fabrication
 - 1. Shop assemble enclosures and cabinets housing terminal blocks or electrical components. Terminal blocks and electrical components shall be mounted on a field removable backplane.
 - 2. Wiring within enclosures shall be routed within snap-cover wireways.
 - 3. Provide knockouts on enclosures.
 - 4. Provide protective pocket inside front cover with schematic diagram, connection diagram and layout drawing of control wiring and components within enclosure.
 - 5. Provide venting as required for cooling of each enclosure. Mechanical shall not be allowed.

3.2 CABINET SUPPORT INSTALLATION

- A. Install surface-mounted cabinets and panelboards with a minimum of four anchors. Provide additional blocking as required between studs to securely anchor the cabinet or panelboard where equipment is to be secured on top of gypsum board, plaster, or hollow masonry walls.
- B. Bridge studs top and bottom of cabinets and panelboards with channels to support flush-mounted cabinets and panelboards in stud walls.

- C. In exterior, wet, or damp locations use steel channel supports to stand cabinets and panelboards 1 inch off wall.

3.3 EQUIPMENT RACK INSTALLATION

- A. Racks shall be installed in the following manner:
 - 1. Racks shall be securely attached to the concrete floor using 3/8" hardware.
 - 2. All racks shall be grounded to the telecommunications ground bus bar.
 - 3. Rack mount screws (#12-24) not used for installing fiber panels and other hardware shall be bagged and left with the rack upon completion of the installation.
- B. Where active equipment is provided in racks, provide one (1) KVM switch within the rack, connected to each low voltage security electronics system, for each low voltage security electronics equipment room. Reference Section 28 46 30 Network Equipment.

3.4 ELECTRICAL BOXES

- A. Provide electrical boxes as shown on the drawings, and as required for splices, taps, wire pulling, equipment connections and Code compliance.
- B. Electrical boxes shown on Drawings are approximate locations unless dimensioned. Obtain verification from Architect, of floor box locations, and locations of outlets in offices and work areas, prior to rough-in.
- C. Locate and install all electrical boxes to allow access. No outlet shall be located where it will be obstructed by other equipment, piping, lockers, benches, counters, etc. Where box is installed in an inaccessible location, provide access doors prior to closing of building finishes. Locate and install boxes to allow access to them. Where installation is inaccessible, coordinate locations and provide 18 inch (450 mm) by 24 inch (600 mm) access doors.
- D. Locate and install electrical boxes to maintain headroom and to present a neat mechanical appearance.
- E. Do not install boxes back-to-back in walls:
 - 1. In stud walls, maintain at least one (1) stud spacing of separation, except provide at least 24 inches (61 cm) separation in acoustic rated walls.
 - 2. In poured concrete walls, maintain at least 18 inches (46 cm) of separation.
 - 3. In CMU walls, maintain at least one CMU block of separation.
- F. Device Boxes: Recessed (1/4" maximum) outlet boxes in masonry, drywall, concrete or tile construction shall be masonry type; minimum 4 11/16 inch square with 4 11/16 inch square-cut device covers. Coordinate masonry cutting to achieve neat openings for boxes.
- G. Support boxes independently of conduit except for cast boxes that are connected to two rigid metal conduits, both supported within 12 inches (300 mm) of box.
- H. Use multiple-gang boxes where more than one device are mounted together; do not use sectional boxes. Provide barriers to separate wiring of different voltage systems.

- I. Locate boxes in masonry walls to require cutting corner only. Coordinate masonry cutting to achieve neat openings for boxes.
- J. Install boxes in walls without damaging wall insulation.
- K. Coordinate mounting heights and locations of outlets mounted above counters, benches and backsplashes.
- L. Provide recessed outlet boxes in finished areas; secure boxes to interior wall and partition studs, accurately positioning to allow for surface finish thickness. Use stamped steel stud bridges for flush outlets in hollow stud wall, and adjustable steel channel fasteners for flush ceiling outlet boxes.
- M. Align wall-mounted outlet boxes for intercoms, pushbutton, card readers, and similar devices.
- N. Boxes shall not be fastened to the metal roof deck.
- O. Provide cast outlet box in exterior locations, where exposed to the weather, and wet locations.
- P. Use hinged enclosure for pull or junction boxes larger than 12 inches in any dimension.
- Q. Locate pull boxes and junction boxes above accessible ceilings or in unfinished areas.
- R. Install boxes to preserve fire resistance rating of partitions and other elements, using approved materials and methods.

END OF SECTION

PART 1 - GENERAL

1.1 SCOPE

- A. Applicable provisions of Division 1 shall govern all work under this Section.
- B. Section Includes:
 - 1. Low Voltage wire and cable.
 - 2. Wire connections and terminations.
- C. Related Sections: The General Low Voltage Requirements, Section 28 00 00, are part of this Section, and the contract for this work, and apply to this Section as fully as if repeated herein.

1.2 SUBMITTALS

- A. Submit all product data listed below under the provisions of Division 1 and Section 28 00 00.
- B. Indicate on shop drawings, shop fabricated enclosures and cabinets; include wiring schematic diagram, wiring diagram, outline drawing and construction diagram.
- C. Product Data: Provide product data for wire, cable, terminations, and splice kits.

1.3 REGULATORY REQUIREMENTS

- A. Materials shall be UL listed and labeled.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Cables and conductors furnished shall be of the type and size as recommended by the equipment manufacturers to support the requirements of the systems, including signal transmission properties.
- B. Conductors for audio, video, data (other than data/telephone circuits) shall be shielded.

2.2 WIRE AND CABLE AND WIRING CONNECTIONS

- A. Manufacturers:
 - 1. #16 AWG and Larger: General Cable, Southwire, Triangle, or approved.
 - 2. #18 AWG and Smaller: West Penn/CDT, Belden, Windy City Wire, or approved.
- B. Building Wire: 600V and below, single conductor, type THW, THHN/THWN or XHHW insulation, rated 600 volts. Insulation shall be rated 75 degrees C unless stated otherwise in other parts of these specifications and drawings.
- C. Building Wire Larger Than 10 AWG and Smaller: Stranded conductor.
- D. All conductors shall be copper.

- E. Control Cable for Class 1 Remote Control and Signal Circuits: Stranded copper conductor, 600 volt insulation, rated 75 degree C, individual conductors twisted together, and covered with a PVC jacket.
- F. Control Cable for Class 2 Remote Control and Signal Circuits: Copper conductor, 300 volt insulation, rated 75 degree C, individual conductors twisted together, and covered with a PVC jacket.
- G. Door control conductors shall be as follows:
 - 1. Interior Door 120V Locks: #14 AWG for devices 10A and less, otherwise #12 AWG.
 - 2. Exterior Gate 120V Locks: #10 AWG.
 - 3. 24VDC Solenoids and Motors: #16 AWG.
- H. Door position indication switch, lock position (jamb) switch and pushbutton switch wiring shall be #16 AWG.
- I. CCTV power wiring shall be #16AWG.
- J. RS-485 Cabling:
 - 1. Non-plenum: West Penn D485x, where x represents the number of conductors required.
 - 2. Plenum: West Penn D25485x, where x represents the number of conductors required.
- K. Fiber Optic Cabling and Terminations: 4 strand OM3 cable: Reference Sections 27 15 00 Structured Cabling System. Cabling shall be the same manufacturer and configuration as provided under this section.
- L. Category 6 wiring and Terminations: Reference Sections 27 15 00 Structured Cabling System. Cabling shall be the same manufacturer and configuration as provided under this section.

PART 3 - EXECUTION

3.1 WIRING

- A. General: In existing facilities, use existing color scheme. In new facilities, conductors shall be color coded to indicate function. Color coding shall be consistent throughout the project.
- B. Use no wire smaller than 14 AWG for control wiring greater than 60 volts and 16 AWG for control wiring voltages less than 60 volts.
- C. No conductor less than 10 AWG shall be installed in exterior underground conduit.
- D. Cabling installed in underground raceways, or raceways installed in slabs shall be wet location listed.
- E. Neatly train and lace wiring inside boxes, equipment, and panelboards.
- F. Install wire in raceway after the interior of the building has been physically protected from weather and construction work which is likely to injure conductors has been completed.

- G. All security electronics system wiring shall be installed in raceways separate from all other systems.
- H. Communications and control cabling shall not be spliced except as approved by the Owner's Representative.
- I. All circuits shall be labeled to indicate field device location, headend panel termination location, and circuit type within each junction box, pull box, wireway or auxiliary gutter, each field device, panel, switch, or conductor termination.
- J. Fiber optic, Category 5, 5e, 6, and 6A cabling shall be terminated in patch panels. Provide patch cords to jumper between patch panels and headend or network equipment.

3.2 FIELD QUALITY CONTROL

- A. Perform continuity test on all power and equipment branch circuit conductors. Verify proper phasing connections; reconnect as required.

3.3 ADJUSTING

- A. Mark all conductors with the panel and circuit number serving the device, at the device.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Applicable provisions of Division 1 shall govern all work under this Section.
- B. Section Includes:
 - 1. Security Screws.
 - 2. Epoxy Grout.
 - 3. Overdoor Indicators.
 - 4. Audible Alarms.
 - 5. Proximity Readers.
 - 6. Duress Alarm Pushbuttons.
- C. Related Sections:
 - 1. The General Low Voltage Requirements, Section 28 00 00, are part of this Section, and the contract for this work, and apply to this Section as fully as if repeated herein.
 - 2. Section 07 92 00 – Joint Sealants.
 - 3. Section 05 05 53 - Tamper Proof Metal Fasteners.

1.2 SUBMITTALS

- A. Submit product data under provisions of Section 28 00 00 and Division 1.
- B. Include dimensioned shop drawings and wiring diagrams.
- C. Product Data: Provide dimensions, ratings, performance data, lamp data, weights and accessory information for each type.

1.3 REGULATORY REQUIREMENTS

- A. Devices shall be assembled of UL listed materials.

1.4 EXTRA MATERIALS

- A. Provide maintenance materials under provisions of Section 01 78 23 – Operation and Maintenance Data.
- B. Provide a minimum of (1) of each field device listed in Part 2 - Products.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Provide security screws for all devices as specified in Section 05 05 53.
- B. Unless otherwise indicated, provide Torx head security screws with center pin reject, for all field devices. Security screws shall be grade 9 alloy steel, austenitic stainless steel or martinsitic steel.
- C. Provide Epoxy Grout for all devices as specified in Section 07920.

- D. Epoxy Grout: Adhesive Engineers Concrete #1411 or #1428 as required by the installation conditions.

2.2 FIELD DEVICES

- A. Overdoor Indicators, Duress Alarm: ABC Control Systems, R series with LED's as indicated below.
 - 1. Single gang back-box
 - 2. Two 24VDC LED lights – both red.
 - 3. Tamper-proof polycarbonate milky white lens cover
 - 4. 304 stainless steel 11 gauge single-gang cover plate
- B. Duress Alarm Pushbuttons
 - 1. Alarm pushbuttons in other than office locations shall be normally closed, red, 40 mm mushroom head "push to latch, twist to release", Microswitch PW3M63. See drawings for mounting detail.
 - a. Provide 4 ½" square, 11ga stainless steel coverplate, brush finish, with black lettering on clear tape reading 'Personal Security Alarm'. Coverplates shall be as manufactured by ABC Control Systems, 714-670-0117.
 - 2. Alarm pushbuttons in office desk locations shall consist of 10 feet of 1 pair #22 AWG stranded copper telephone type cable with a United Security # HUB2B normally closed, custom mounted pushbutton installed on one end and a 4 conductor modular plug installed on the other end to match the wall jack specified below. Leave with modular plug inserted and cable coiled on the floor adjacent to the outlet until furniture is installed. After installation of furniture, install the custom mounted pushbutton in the manner directed by the Architect. Provide each pushbutton with a # HUBRT release tool. United Security Products, Inc., San Diego, California; (T) 1-800-227-1592.
 - 3. Outlets for alarm pushbuttons located in office areas shall consist of a screw terminal, flush mounted, 4 conductor modular wall jack, Leviton type 630A, Catalog # 40257-I.
- C. Wall-mounted Push-To-Exit Buttons:
 - 1. Pushbuttons shall be Camden Door Controls #CM-9080PTE or approved equal.
 - a. DPDT momentary spring return switch, rated 6A @ 30VDC.
 - b. 2 ¾" single-gang faceplate, ¼" brushed aluminum.
 - c. Coverplates shall be engraved with door name and number to indicate which door is being controlled.
- D. Proximity Card Readers: Reference Section 28 13 00 Access Control Systems.

PART 3 - EXECUTION

3.1 INSTALLATION OF LOW VOLTAGE ELECTRONICS SYSTEMS

- A. Security screws shall be provided for all field devices

- B. Provide epoxy grout around all wall mounted devices located within secure areas, including secure corridors, dayrooms or cells. Reference the Architectural Drawings for security ratings.
- C. Install all devices flush and level.
- D. Mounting locations for all devices shall be as shown on the drawings.
- E. Mount proximity readers in accordance with manufacturer's instructions.

END OF SECTION

PART 1 - GENERAL

1.1 SCOPE

- A. Applicable provisions of Division 1 shall govern all work under this Section.
- B. Section Includes:
 - 1. Grounding electrodes and conductors, equipment grounding conductors and bonding.
- C. Related Sections: The General Low Voltage Requirements, Section 28 00 00, are part of this Section, and the contract for this work, and apply to this Section as fully as if repeated herein.
- D. References
 - 1. ANSI/NFPA 70 - National Electrical Code.
 - 2. IEEE/ANSI 142-Latest edition - Recommended Practice for Grounding of Industrial and Commercial Power System.

1.2 PERFORMANCE REQUIREMENTS

- A. Grounding System Resistance: 2 ohms.

1.3 SUBMITTALS:

- A. Submit all product data listed below under the provisions of Division 1 and Section 28 00 00.
- B. Submittals for Approval:
 - 1. Submit all product data listed below under the provisions of Division 1 and Section 28 00 00.
 - 2. Product Data: Provide data for grounding electrodes and connections.
- C. Submittals for Close-Out:
 - 1. Product Data: Provide updated information for all Product Data.
 - 2. Test Reports: Indicate overall resistance to ground and resistance of each electrode.
 - 3. Accurately record actual locations of grounding electrodes.

1.4 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five years documented experience.

1.5 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Thompson Lightning Protection, Burndy, Crouse-Hinds, B-Line Systems, Harger Lightning Protection, or approved equal.

2.2 CONNECTORS

- A. Mechanical Connectors:
 - 1. The mechanical connector bodies shall be manufactured from high strength, high conductivity cast copper alloy material. Bolts, nuts, washers and lockwashers shall be made of Silicon Bronze and supplied as a part of the connector body and shall be of the two bolt type.
 - 2. Split bolt connector types are NOT allowed.
 - 3. The connectors shall meet or exceed UL 467 and be clearly marked with the catalog number, conductor size and manufacturer.
- B. Compression Connectors:
 - 1. The compression connectors shall be manufactured from pure wrought copper. The conductivity of this material shall be no less than 99% by IACS standards.
 - 2. The connectors shall meet or exceed the performance requirements of IEEE 837, latest revision.
 - 3. The installation of the connectors shall be made with a compression, tool and die system, as recommended by the manufacturer of the connectors.
 - 4. The connectors shall be clearly marked with the manufacturer, catalog number, conductor size and the required compression tool settings.
 - 5. Each connector shall be factory filled with an oxide-inhibiting compound.

2.3 WIRE

- A. General: Aluminum wire or conductors are not permitted.
- B. Equipment Grounding Conductor: Stranded copper wire, size as shown on the drawings, specifications or as required by NFPA 70, whichever is larger. Minimum size shall be #6 AWG, except for field devices, minimum size shall be #12 AWG.

2.4 GROUND BUS

- A. Ground bus shall be copper, 1/4" x 4" wide, minimum length of 24", with wall-mounting brackets and 2700V insulated standoffs. Provide pre-drilled holes. Provide 3/4" conduit with #6 AWG insulated grounding conductor from the ground bus to the service ground and connect.
- B. Ground bus shall be Harger #GBI 14424 BT.

PART 3 - EXECUTION

3.1 GENERAL

- A. Install Products in accordance with manufacturer's instructions.
- B. Mechanical connections shall be accessible for inspection and checking. No insulation shall be installed over mechanical ground connections.
- C. Ground connection surfaces shall be cleaned and all connections shall be made so that it is impossible to move them.
- D. Attach grounds permanently before equipment is energized.
- E. Provide bonding to meet Regulatory Requirements.
- F. All separate ground wires shall be enclosed in rigid galvanized steel conduit and bonded at both ends to the rigid galvanized steel conduit with an approved fitting.

3.2 FIELD DEVICES

- A. Provide #12 AWG ground conductor in all conduit to exterior doors and doors located in damp or wet locations, specifically shower units and toilet facilities. Bond ground conductor to door frame.
- B. Provide #12 AWG ground conductor in all conduit to wall mounted field devices located in damp or wet locations, specifically shower units and toilet facilities.
- C. Provide exothermic connection to door frames which have 120VAC locking hardware.

3.3 EQUIPMENT RACK AND WALL MOUNTED ENCLOSURE GROUNDING

- A. Use minimum no. 6 AWG copper conductor, or larger as indicated on the plans, for low voltage systems grounding conductor.
- B. Provide communications system grounding conductor at point of service entrance and connect to [nearest effectively grounded metallic water pipe.] [nearest effectively grounded building structural steel member.] [separate grounding electrode.] Extend the conductor to each low voltage electronics room.

3.4 WIREWAY AND CABLE TRAY GROUNDING

- A. Use minimum no. 6 AWG copper conductor, or larger as indicated on the plans, for wireway and cable tray grounding conductor.
- B. Provide continuity between wireway and cable tray components. Use anti-oxidant compound to prepare aluminum contact surfaces before assembly. Provide copper equipment grounding conductor through entire length of wireway and tray; bond to each component. Connections to wireway and tray may be made using clamps specifically manufactured for the purpose.
- C. Conduits stubbed into cable tray, or terminated within 24" of cable tray shall be bonded to the cable tray with a minimum #6AWG conductor.
- D. Bond all transitions of metallic pathways.

- E. Provide system grounding to ground bus located in the security electronics and/or data/telephone equipment room and as indicated on the Drawings.

3.5 FIELD QUALITY CONTROL

- A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.
- B. Use suitable test instrument to measure resistance to ground of system. Perform testing in accordance with test instrument manufacturer's recommendations using the fall-of-potential method. Measure ground resistance from system neutral connection at service entrance to convenient ground reference point using suitable ground testing equipment. Resistance shall not exceed 2 ohms.

END OF SECTION

PART 1 - GENERAL

1.1 SCOPE

- A. Applicable provisions of Division 1 shall govern all work under this Section.
- B. Section Includes:
 - 1. Metal conduit.
 - 2. Flexible metal conduit.
 - 3. Liquidtight flexible metal conduit.
 - 4. Electrical metallic tubing.
 - 5. Nonmetal conduit.
 - 6. Fittings and conduit bodies.
 - 7. Expansion and deflection fittings
 - 8. Sealing and firestopping.
 - 9. Water blocking duct sealant.
- C. Related Sections:
 - 1. The General Low Voltage Requirements, Section 28 00 00, are part of this Section, and the contract for this work, and apply to this Section as fully as if repeated herein.
 - 2. Section 07 84 00 – Firestopping.
 - 3. Section 28 05 29 – Supporting Devices

1.2 SUBMITTALS

- A. Submit all product data listed below under the provisions of Division 1 and Section 28 00 00.
- B. Submittals for Approval:
 - 1. Product Data - Conduit: Provide data for metallic conduit, flexible metal conduit, liquidtight flexible metal conduit, metallic tubing, nonmetallic conduit, flexible nonmetallic conduit, nonmetallic tubing, fittings, and conduit bodies.
 - 2. Product Data - Fire Sealants: Contractor shall submit product data for each firestop system. Submittals shall include product characteristics, performance and limitation criteria, test data, MSDS sheets, installation details and procedures for each method of installation applicable to this project. For non-standard conditions where no UL tested system exists, submit manufacturer's drawings for UL system with known performance for which an engineering judgment can be based upon.
 - 3. Shop Drawings:
 - a. Submit a facility conduit plan prior to construction showing the routing of all conduits and the mounting of the conduits (e.g. below grade, concealed, surface mounted, etc.), the locations and sizes of all pull and junction boxes, the field devices and equipment where the conduits terminate, and cable or wiring within each of the conduits. Shop drawing shall be generated using a computer aided drafting program and forwarded to the Owner's Representative in .DWG or .DXF format. Shop drawing submittal shall be the same size as the contract documents.

- 1) The following systems shall be segregated into separate homeruns:
 - a) Closed circuit television (CCTV) systems.
 - b) Intercom and paging systems.
 - c) Class 2 systems including Pushbutton Duress Alarm, Electric Door Locks/Strikes, and Door Position Indication Switches.
 - d) Class 1 systems, including electric door locks/strikes.
 - e) Duress Alarm System.
 - f) Access control system card readers.
 - g) Network backbone systems including copper and fiber optic connectivity.
 - h) Interface to elevator control.
 - i) Interface to air or water control systems.
 - j) Interface to lighting control systems.

C. Submittals for Close-out:

1. Product Data: Provide updated information for all Product Data.
2. As-Built Drawings: Provide updated information for all Shop Drawings.

1.3 REGULATORY REQUIREMENTS

- A. Products shall be UL listed and labeled.

PART 2 - PRODUCTS

2.1 RIGID METAL CONDUIT AND FITTINGS

- A. Manufacturers: Allied Tube and Conduit, LTV, Triangle PWC, Western Tube and Conduit, or equal.
- B. Conduit: Heavy wall, galvanized steel, schedule 40, threaded.
- C. Fittings and Conduit Bodies: ANSI/NEMA FB 1; Threaded galvanized or cadmium plated steel fittings. Bushings shall have nylon insulated throats.
- D. Rigid Steel Conduit (RGS): ANSI C80.1.
- E. Intermediate Metal Conduit (IMC): Rigid steel.

2.2 ELECTRICAL METALLIC TUBING (EMT) AND FITTINGS

- A. Manufacturers: Allied Tube and Conduit, LTV, Triangle PWC, or equal.
- B. Description: ANSI C80.3; galvanized tubing.
- C. Fittings and Conduit Bodies: ANSI/NEMA FB 1; steel, rain tight compression type with nylon insulated throats on connectors. All steel threaded conduit bodies.

2.3 FLEXIBLE METAL CONDUIT AND FITTINGS

- A. Manufacturers: AFC, Anamet, Triangle PWC, or equal.

- B. Description: Flexible, interlocked, galvanized steel construction, spiral strip.
- C. Fittings and Conduit Bodies: ANSI/NEMA FB 1. All steel, galvanized, clamp type. Specifically designed for the purpose.

2.4 LIQUIDTIGHT FLEXIBLE METAL CONDUIT AND FITTINGS

- A. Manufacturers: AFC, Anamet, Electriflex, Alfex, or equal.
- B. Conduit: Flexible, interlocked, galvanized steel, spiral strip with an outer liquidtight, nonmetallic, sunlight-resistant jacket.
- C. Fittings and Conduit Bodies: ANSI/NEMA FB 1, compression type. There shall be a metallic cover/insert on the end of the conduit inside the connector housing to seal the cut conduit end.

2.5 RIGID NONMETALLIC CONDUIT AND FITTINGS

- A. Manufacturers: Carlon, PW Pipe, Triangle PWC, or equal.
- B. Conduit: Schedule NEMA TC 2; 40 PVC minimum, Listed, sunlight resistant, rated for 900 C conductors.
- C. Fittings and Conduit Bodies: NEMA TC 3, Listed.

2.6 EXPANSION AND DEFLECTION FITTINGS

- A. Fittings shall conform to UL 467 and UL 514B.
- B. Fittings shall accommodate a 0.75 in (19 mm) deflection, expansion, or contraction in any direction, and allow 30 degree angular deflections.
- C. Fittings shall include internal flexible metal braid, sized to guarantee conduit ground continuity and a low-impedance path for fault currents, in accordance with UL 467 and the NEC tables for equipment grounding conductors.
- D. Jacket: Flexible, corrosion-resistant, watertight, moisture and heat-resistant molded rubber material with stainless steel jacket clamps.

2.7 CABLE TRAY

- A. See Section 28 05 36.

2.8 CONDUIT SUPPORTS

- A. See Section 28 05 29.

2.9 GENERAL

- A. All steel fittings and conduit bodies shall be galvanized.
- B. No cast metal, split or gland type fittings permitted.
- C. Condulets larger than 2 inch (50 mm) not permitted except as approved or detailed.
- D. All conduit covers must be fastened to the conduit body with screws and be of the same manufacture.

- E. Wireways and gutters shall not be used in lieu of pull boxes and condulets.

2.10 SEALING AND FIRESTOPPING

- A. Fire and/or Smoke Rated Penetrations:

- 1. Manufacturers: 3M, STI/SpecSeal, Tremco, or approved equal. All firestopping systems shall be provided by the same manufacturer.
- 2. Product: Firestop systems shall be UL listed. Use a product that has a rating not less than the rating of the wall or floor being penetrated. Reference architectural drawings for identification of fire and/or smoke rated walls and floors. Contractor shall use firestop putty, caulk sealant, intumescent wrapstrips, intumescent firestop collars, firestop mortar or a combination of these products to provide a UL listed system for each application required for this project. Provide mineral wool backing where specified in manufacturer's application detail.

- B. Non-Rated Penetrations:

- 1. Conduit Penetrations Through Below Grade Walls: In exterior wall openings below grade, use a modular mechanical type seal consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the uninsulated conduit and the cored opening or a water-stop type wall sleeve.
- 2. Conduit and Cable Tray Penetrations: At conduit and cable tray penetrations of non-rated interior partitions, floors and exterior walls above grade, use urethane caulk in annular space between conduit and sleeve, or the core drilled opening.

2.11 WATER BLOCKING DUCT SEALANT

- A. For conduits 1 1/2" and less, water blocking duct sealant shall be Polywater FST-Mini or approved equal.
- B. For conduits 2" and larger, water blocking duct sealant shall be Polywater FST-250 or approved equal.

PART 3 - EXECUTION

3.1 CONDUIT SIZING, ARRANGEMENT, AND SUPPORT

- A. EMT is permitted to be used in sizes 4" (100 mm) and smaller for security electronics systems. See CONDUIT INSTALLATION SCHEDULE below for other limitations for EMT and other types of conduit.
- B. Size power conductor raceways for conductor type installed or for Type THW conductors, whichever results in larger conduit.
 - 1. Interior conduit size shall be 3/4 inch (19 mm) minimum;
 - 2. Exterior conduit size shall be 1 inch (25.4 mm) minimum;
 - 3. Except as specified elsewhere or with specific Engineer's approval for each application.
 - 4. Conduits larger than indicated above for all other wiring, including but not limited to data, control, security, fire alarm, telecommunications, signal, video, etc. shall be sized per number of conductors pulled and their cross-section with a 40% fill maximum allowed.
 - 5. Conductors for multiple field devices or outlets of the same system may be combined, or aggregated into a larger branch run or homerun conduit.

Where the conduit contains wiring for more than one field device or outlet of the same system, the 40% maximum cable fill shall be maintained.

- 6. Conductors of different systems shall not be routed within the same conduit.
- C. Arrange conduit to maintain headroom and present a neat appearance.
- D. Route exposed conduit and conduit above accessible ceilings parallel and perpendicular to walls and adjacent piping.
- E. Maintain minimum 6 inch (150 mm) clearance between conduit and piping. Maintain 12 inch (300 mm) clearance between conduit and heat sources such as flues, steam pipes, and heating appliances.
- F. Arrange conduit supports to prevent distortion of alignment by wire pulling operations. Fasten conduit using galvanized pipe straps, conduit racks (lay-in adjustable hangers), clevis hangers, or bolted split stamped galvanized hangers.
- G. Group conduit in parallel runs where practical and use conduit rack (lay-in adjustable hangers) constructed of steel channel with conduit straps or clamps. Provide space for 25 percent additional conduit.
- H. Do not fasten conduit with wire or perforated pipe straps. Before conductors are pulled, remove all wire used for temporary conduit support during construction.
- I. Support and fasten metal conduit at a maximum of 8 feet (2.4 m) on center.
- J. Support and fasten PVC conduit as follows:

Conduit Size Inches(mm)	Maximum spacing between supports Feet (meters)
1/2(13) - 1(25)	3(0.9)
1 1/4(31) - 2(50)	5(1.5)
2 1/2(60) - 3(75)	6(1.8)
2 1/2(60) - 3(75)	7(2.1)

- K. Supports shall be independent of the installations of other trades, e.g. ceiling support wires, HVAC pipes, etc., unless so approved or detailed.
- L. In general, all conduit shall be concealed except where noted on the drawings or approved by the Architect/Engineer. Contractor shall verify with Architect/Engineer all surface conduit installations except in mechanical rooms.
- M. Changes in direction shall be made with symmetrical bends, cast steel boxes, stamped metal boxes or cast steel conduit bodies.
- N. No continuous conduit run shall exceed 100 feet (30 meters) without a junction box.

3.2 CONDUIT INSTALLATION

- A. Branch circuit runs are shown schematically. Except where exact routing is indicated, branch circuit home runs may be grouped and the actual routing of branch circuit conduits may be determined at the site and properly entered on the "As-Built" drawings.

- B. Cut conduit square using a saw or pipe cutter; de-burr cut ends.
- C. Conduit shall not be fastened to the corrugated metal roof deck.
- D. Bring conduit to the shoulder of fittings and couplings and fasten securely.
- E. Use conduit hubs for fastening conduit to cast boxes. Use sealing locknuts or conduit hubs for fastening conduit to sheet metal boxes in damp or wet locations. (Sheet metal boxes larger than 4 & 11/16th square shall contain NO pre-punched or concentric knockouts)
- F. All conduit terminations (except for terminations into conduit bodies) shall use insulated throat connectors or conduit hubs with one locknut or shall use double locknuts (one each side of box wall) and insulating bushing. Provide bushings for the ends of all conduit not terminated in box walls. Refer to Section 28 05 36 Low Voltage Grounding and Bonding for grounding bushing requirements. Ground and bond conduit under provisions of Section 28 05 26.
- G. Install no more than the equivalent of three 90 degree bends between boxes.
- H. Use hydraulic one-shot conduit bender or factory elbows for bends in conduit larger than 2 inch (50 mm) size unless sweep elbows are required.
- I. Conduit shall be bent according to manufacturer's recommendations. Torches or open flame shall not be used to aid in bend of PVC conduit.
- J. Use suitable conduit caps or other approved seals to protect installed conduit against entrance of dirt and moisture.
- K. Provide 1/8 inch (3 mm) nylon pull string in empty conduit, except sleeves and nipples.
- L. Install expansion-deflection joints where conduit crosses building expansion joints. Note: expansion-deflection joints are not required where conduit crosses building control joints if the control joint does not act as an expansion joint. Install expansion fitting in PVC conduit runs as recommended by the manufacturer.
- M. Avoid moisture traps where possible. Where moisture traps are unavoidable, provide junction boxes with drain fittings at conduit low points.
- N. Conduit support and separations:
 - 1. Maintain a 6" (15.2cm) separation from all hot water or steam piping and 18" (45.7cm) from the insulation or covering of mechanical exhaust flues.
- O. Route conduit through roof openings for piping and ductwork where possible.
- P. Conduit is not permitted in any slab topping of two inches (50 mm) or less.
- Q. Maximum Size Conduit in Slabs Above Grade: ¾ inch (19 mm). Do not route conduits to cross each other in slabs above grade.
- R. PVC elbows are allowed in PVC conduit runs 4" (103mm) and smaller. Note: PVC conduit must transition to galvanized rigid metal conduit before it runs up through a concrete floor.

- S. All conduit installed underground (exterior to the building) shall be buried a minimum of 24" below finished grade, whether or not the conduit is concrete encased.
- T. Conduits containing audio/visual, low voltage, telephone or data cabling shall be NOT be routed below slab unless the cables contained within are wet location rated and listed for interior use.
- U. Identify conduit under provisions of Section 28 05 53.

3.3 CONDUIT PENETRATIONS

- A. Provide sleeves for each conduit that passes through concrete walls or suspended slabs. Sleeves in concrete beams, joists, columns or footing walls may be installed only where permitted by the Architect. For conduit that passes through suspended concrete slabs, place sleeves with the top two inches above finished slab and the bottom flush with underside of slab. In all other cases, place sleeves with the ends flush with the concrete surfaces. Space sleeves at least three diameters apart on center.
- B. Where conduit penetrates roof, route conduit through openings for piping and ductwork where possible; otherwise, route through roof jack with pitch pocket. The neck of the flashing and the conduit shall be sealed with waterproofing compound as recommended by the manufacturer of the assembly.
- C. Where conduit passes between areas of differing temperatures such as into or out of cool rooms, freezers, unheated and heated spaces, buildings, or where conduit is exposed to the weather or in wet locations, etc., provide UL Listed conduit seals to prevent the passage of moisture and water vapor through the conduit.
- D. Pipe sleeves for conduits 6" in diameter and smaller, in new poured concrete construction, shall be schedule 40 steel pipe, plastic removable sleeve or sheet metal sleeve, all cast in place.
- E. In wet area floor penetrations, top of sleeve to be 2 inches above the adjacent floor. In existing wet area floor penetrations, core drill sleeve openings large enough to insert schedule 40 sleeve and grout the area around the sleeve. If the pipe penetrating the sleeve is supported by a pipe clamp resting on the sleeve, weld a collar or struts to the sleeve that will transfer weight to the existing floor structure. Wet areas for this paragraph are rooms or spaces containing air handling unit coils, converters, pumps, chillers, boilers, and similar waterside equipment. Pipe penetrations in existing concrete floors that are not in wet areas may omit the use of schedule 40 sleeve and use the core drilled opening as the sleeve.
- F. Conduit penetrations through basement exterior concrete walls shall be core-drilled and a modular mechanical type sealing closure shall be installed between the conduit and the concrete wall cut-out. Cut-outs and installation of the sealing closure shall be in accordance with the manufacturer's instructions.

- G. Fire and/or Smoke Penetrations:
1. Install approved product in accordance with the manufacturer's instructions where a pipe (i.e. cable tray, bus, cable bus, conduit, wireway, trough, etc.) penetrates a fire rated surface.
 2. Where firestop mortar is used to infill large fire-rated floor openings that could be required to support weight, provide permanent structural forming. Firestop mortar alone is not adequate to support any substantial weight.
- H. Non-Rated Surfaces:
1. When the opening is through a non-fire rated wall, floor, ceiling or roof the opening must be sealed using an approved type of material.
 2. Use galvanized sheet metal sleeves in hollow wall penetrations to provide a backing for the sealant. Grout area around sleeve in masonry construction.
 3. Install escutcheons or floor/ceiling plates where conduit penetrates non-fire rated surfaces in occupied spaces. Occupied spaces for this paragraph include only those rooms with finished ceilings and the penetration occurs below the ceiling.
 4. In exterior wall openings below grade, assemble rubber links of mechanical seal to the proper size for the conduit and tighten in place, in accordance with the manufacturer's instructions.
 5. At interior partitions, conduit penetrations are required to be sealed for all clean rooms, laboratories, hospital spaces, computer rooms, dormitory rooms, tele/data/com rooms and similar spaces where the room pressure or odor transmission must be controlled. Apply sealant to both sides of the penetration in such a manner that the annular space between the conduit sleeve and the conduit is completely filled.

3.4 CONDUIT INSTALLATION SCHEDULE

- A. Conduit other than that specified below for specific applications shall not be used.
- B. In prisons or similar applications a separate rigid conduit system shall be used for all security systems in locations potentially accessible to inmates, including door and lock controls, intercom, paging, monitoring and video systems.
1. Interior conduit systems:
 - a. Rigid steel conduit for all exposed locations. Note: conduit may be routed in exposed locations only where specifically indicated on the drawings. Exception: Low Voltage Security Electronics rooms.
 - b. All metallic conduits installed underslab shall be painted with two coats of asphaltic compound or wrapped with one half-lapped layer of Hunt's Wrap Process No. 3. Alternate installation: provide PVC coated metallic conduits.
 - c. Intermediate metallic conduit in concrete or masonry walls.
 - d. In grout filled detention hollow metal frames, rigid steel conduit or intermediate metallic conduit. EMT shall not be used.
 - e. Electrical metallic tubing above ceilings and in framed walls.

- f. Within Low Voltage Security Electronics rooms, cable tray may be used for routing conduits between field device homeruns and system interconnects to headend equipment. Provide dividers within each cable tray to maintain system separation and NEC separation.
 - g. PVC conduit is allowed under slab and in fully grouted masonry walls.
 - h. Minimum size of conduit shall be $\frac{3}{4}$ " (19 mm).
2. Exterior Conduit systems, more than 5'0" from building foundation walls:
- a. Rigid steel conduit for all exposed locations. Note: conduit may be routed in exposed locations only where specifically indicated on the drawings.
 - b. All metallic conduits installed underground shall be painted with two coats of asphaltic compound or wrapped with one half-lapped layer of Hunt's Wrap Process No. 3. Alternate installation: provide PVC coated metallic conduits. Alternate installation #2: Schedule 40 PVC conduit.
 - c. Minimum size of conduit shall be 1" (25.4 mm).
 - d. All underground control and communication conduits shall have a minimum earth cover of eighteen (18) inches, except where subjected to vehicular traffic (to include road right-of-way) the minimum cover shall be thirty (30) inches. Control and communications conduit may be buried in the same trench as power, if separated by a minimum of three (3) inches of concrete or twelve (12) inches of dirt.

END OF SECTION

PART 1 - GENERAL

1.1 SCOPE

- A. Applicable provisions of Division 1 shall govern all work under this Section.
- B. Section Includes:
 - 1. Conduit and equipment supports.
 - 2. Anchors and fasteners.
- C. Related Sections: The General Low Voltage Requirements, Section 28 00 00, are part of this Section, and the contract for this work, and apply to this Section as fully as if repeated herein.

1.2 SUBMITTALS

- A. Submittals for Approval:
 - 1. Submit all product data listed below under the provisions of Division 1 and Section 28 00 00.
 - 2. Product Data: Provide manufacturer's catalog data for fastening systems.
 - 3. Products: Listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.
- B. Submittals for Close-out:
 - 1. Submit all product data listed below under the provisions of Division 1 and Section 28 00 00.
 - 2. Product Data: Provide manufacturer's catalog data for fastening systems.

1.3 REGULATORY REQUIREMENTS

- A. Products shall be UL listed and labeled.

PART 2 - PRODUCTS

2.1 MATERIAL

- A. Manufacturers: B-Line or approved equal.
- B. Support Channel: Galvanized.
- C. Hardware: Corrosion resistant.

- D. Spring Hangers: Spring hangers for conduits 1 1/2" and less shall be B-Line B3262 series. Spring Hangers for conduits 2" and greater shall be spring cushion hangers, B-Line B3264 series. Spring hangers for equipment shall be in accordance with the table below:

	Rod Size	B-Line Number
Less than 100lbs	3/8"	B3262-3/8
Less than 150lbs	1/2"	B3262-1/2
Less than 275lbs	5/8"	B3262-5/8
Less than 400lbs	3/4"	B3262-3/4

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

- A. Design supports to carry weight of equipment and conduit, including wiring.
- B. Fasten hanger rods, conduit clamps, and outlet and junction boxes to building structure using expansion anchors, or beam clamps.
- C. File and debur cut ends of support channel and spray paint with cold galvanized paint to prevent rusting.
- D. Use toggle bolts or hollow wall fasteners in hollow masonry, plaster, or gypsum board partitions and walls; expansion anchors or preset inserts in solid masonry walls; self-drilling anchors or expansion anchor on concrete surfaces; sheet metal screws in sheet metal studs; and wood screws in wood construction.
- E. Do not fasten supports to piping, ductwork, mechanical equipment, cable tray or conduit.
- F. Do not use powder-actuated or plastic anchors.
- G. Do not drill structural steel members unless approved by the Architect.
- H. Fabricate supports from galvanized structural steel or steel channel, rigidly welded or bolted to present a neat appearance. Use hexagon head bolts with spring lock washers under all nuts.
- I. In wet locations, mechanical rooms and electrical rooms install free-standing electrical equipment on four (4) inch (100 mm) concrete pads.
- J. Furnish and install all supports as required to fasten all electrical components required for the project, including free standing supports required for those items remotely mounted from the building structure, catwalks, walkways etc.
- K. Minimum sized threaded rod for supports shall be 3/8".

3.2 BOX SUPPORT INSTALLATION

- A. Support boxes independently of raceway.

3.3 CONDUIT SUPPORT INSTALLATION

- A. Arrange conduit supports to minimize movement during wire pulling operations. Fasten conduits using galvanized straps, lay-in adjustable hangers, clevis hangers, or bolted split stamped galvanized hangers.
- B. Use conduit rack constructed of steel channel with conduit straps or clamps for parallel conduit installations. Provide space for 25 percent additional conduits.
- C. Do not fasten conduit with wire or perforated pipe straps. Remove wire used for temporary conduit support during construction, before conductors are pulled.
- D. Conduit clamps, straps, supports, etc., shall be steel or malleable iron. All straps shall have steel or malleable backing plates.
- E. Provide spring hanger supports for all conduits and equipment supported from the ceiling in areas where vibration isolation is required. Reference the architectural drawings for locations.

3.4 CONTROL PANEL AND CABINET SUPPORT INSTALLATION

- A. Install surface-mounted cabinets and control panels with a minimum of four anchors. Provide additional blocking as required between studs to securely anchor the cabinet or control panels where equipment is to be secured on top of gypsum board, plaster, or hollow masonry walls.
- B. Bridge studs top and bottom of cabinets and control panels with channels to support flush-mounted cabinets and control panels in stud walls.
- C. In exterior, wet, or damp locations use steel channel supports to stand cabinets and control panels 1 inch off wall.

END OF SECTION

PART 1 - GENERAL

1.1 SCOPE

- A. Applicable provisions of Division 1 shall govern all work under this Section.
- B. Section Includes:
 - 1. Ladder Type Cable Tray.
- C. Related Sections:
 - 1. The General Low Voltage Requirements, Section 28 00 00, are part of this Section, and the contract for this work, and apply to this Section as fully as if repeated herein.
 - 2. Section 07 84 00 – Firestopping.

1.2 SUBMITTALS

- A. Submit all product data listed below under the provisions of Division 1 and Section 28 00 00.
- B. Submittals for Approval:
 - 1. Product Data – Cable tray type, fittings, offsets, dimensions, accessories, and support requirements.
 - 2. Shop Drawings:
 - a. Submit a facility layout plan prior to construction showing the routing of all cable trays, fittings and offsets, support points, mounting, ground connections. Shop drawing shall be generated using a computer aided drafting program and forwarded to the Architect in .DWG or .DXF format. Shop drawing submittal shall be the same size as the contract documents.
- C. Submittals for Closeout:
 - 1. Operations and Maintenance Manuals
 - a. Product Data: Provide updated information for all Product Data.
 - 2. As-Built Drawings
 - a. As-Built Drawings: Provide updated information for all Shop Drawings.

1.3 REGULATORY REQUIREMENTS

- A. Materials shall be UL listed and labeled.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Manufacturers: Chalfant, Cooper B-Line, MP Husky, Thomas & Betts, or approved equal.
- B. Cable trays shall support a continuous loading of cables weighing 75 lbs. per linear foot, when supported on 12'-0" centers, without any deflection exceeding 1/100 part of the span, with a safety factor of 1.50.

- C. Provide all necessary manufacturers standard fittings for the cable tray including, but not limited to 45° and 90° flat, vertical inside and outside elbows, tee and cross fittings, couplings for joining sections of the tray, reducers, hangers, end blanks, a field-installed divider and all other components necessary to make the system workable. The fittings shall be finished to match the cable tray.
- D. No on-site fabricated transitions shall be accepted.

2.2 LADDER CABLE TRAY

- A. Description: Prefabricated structure consisting of two longitudinal siderails connected by individual transverse members. NEMA VE 1, Class 12A ladder type tray, steel. Finish shall be ASTM A 123, hot dipped galvanized after fabrication.
- B. Dimensions: Width as indicated on the Drawings, depth shall be nominally 3-1/2". Straight section rung spacing shall be 9 inches on center. Inside radius of fittings shall be 24 inches.
- C. Provide manufacturer's standard clamps, hangers, brackets, splice plates, reducer plates, blind ends, barrier strips, connectors, and grounding straps.

2.3 CABLE TRAY ACCESSORIES

- A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.
- B. Covers: Solid, Louvered, Ventilated-hat, 2-in-3 pitch type made of same materials and with same finishes as cable tray.
- C. Barrier Strips: Same materials and finishes as for cable tray.
- D. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.
- E. Runway Mounting Plate Kits: Where cable runway mounts to the top of equipment racks, provide mounting plate kits, each equipped with a mounting plate, two brackets, two J-bolts, and hex nuts and lock washers to attach runway to top of each rack. Chatsworth #12730-X18, or equal.

2.4 SUPPORTS

- A. Manufacturers: Allied Tube and Conduit, LTV, Triangle PWC, or equal.
- B. Provide wall brackets in main corridors and all other public areas. Contractor shall attach cable tray to bracket.
- C. In electrical rooms, telecommunications closets, and where indicated on the Drawings, provide channel supports. Single channel supports shall be formed, steel type with finish as specified by Architect.
- D. Provide center-hung cable tray supports where indicated on the drawings.

2.5 SEALING AND FIRESTOPPING

- A. Fire stop pillows for penetrations through fire separations shall be non-toxic intumescent type. Pillows shall be UL listed with a fire rating of 3 hours.
- B. Fire stop pillows shall be equal to Nelson PLW fire stop pillows.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install metallic cable tray in accordance with NEMA VE 2 and manufacturer's instructions.
- B. Unless otherwise indicated, use ladder type cable trays in telecom closets, and corrugated solid bottom trough type in corridors, lobbies, classrooms, and other public spaces.
- C. Coordinate installation of cable tray with mechanical ductwork and sprinkler system piping so that tray remains accessible (minimum 1 ft clear above tray bottom) after installation. Provide 24" separation from all heat sources. Coordinate exact routing with all trades to avoid interference.
- D. Maintain 24" separation from all 277/480V branch circuits and feeders. Maintain 24" from all luminaire electronic drivers.
- E. Support cable tray wall brackets, spaced typically 4'-0" on center, 6'-0" on center maximum. Provide additional brackets on ends, and two additional brackets at tees and corners. Securely fasten tray to brackets using clamps, manufactured for the purpose. Only where indicated, shall cable tray be center hung. See electrical drawings and/or Architectural reflected ceiling plans for typical locations. Attach center hung brackets to structural ceiling using 1/2" threaded steel rods on a spacing not to exceed 6'-0" centers. Reference Section 26 05 29 – Supporting Devices for additional requirements.
- F. Mount bottom of tray at elevations indicated on the Drawings. If not so indicated, mount tray at 8'6" above floor around the circumference of all communications rooms. Tray installed parallel and adjacent to wall shall have not less than 4" and no more than 6" of space between tray and wall.
- G. Finished tray shall be located below ceiling and shall have a minimum clearance of 8" above and the open side of the tray.
- H. Install cable tray utilizing manufacturer's standard, factory fabricated transitions (intersections, waterfalls, corners, etc.). Transitions shall not be smaller than 90°. Field or job site fabricated transitions will not be allowed.
- I. All cable tray systems shall be mechanically continuous and connected to all electrical boxes, and cabinets, also in accordance with manufacturer's installation sheets.
- J. Provide cable tray waterfalls for all conductors entering at the tops of all floor mounted equipment racks, sized for the openings to the equipment racks.

3.2 GROUNDING AND BONDING

- A. Provide grounding and bonding in accordance with the provisions of Section 28 05 26 – Low Voltage Grounding and Bonding.

3.3 CABLE TRAY CONDUIT PENETRATIONS

- A. Fire and/or Smoke Penetrations: Seal penetration with fire retardant pillows. Pillows shall be installed in a manner to obtain a 3-hour fire rating. Seal

penetration only after communication cables and other system distribution cables have been installed.

- B. Expansion Joints: Install expansion deflection joints where cable tray crosses building expansion joints.

END OF SECTION

PART 1 - GENERAL

1.1 SCOPE

- A. Applicable provisions of Division 1 shall govern all work under this Section.
- B. Section Includes:
 - 1. Nameplates and labels.
 - 2. Wire and cable markers.
 - 3. Wire and cable
 - 4. Conduit markers.
- C. Related Sections: The General Low Voltage Requirements, Section 28 00 00, are part of this Section, and the contract for this work, and apply to this Section as fully as if repeated herein.

1.2 SUBMITTALS

- A. Submit all product data listed below under the provisions of Division 1 and Section 28 00 00.
- B. Submittals for Approval:
 - 1. Include schedule for nameplates and stenciling.
 - 2. Include color coding schedule for all wiring and conduit.
 - 3. Prior to installation, the Contractor shall provide samples of all label types planned for the project. These samples shall include examples of the lettering to be used. Samples shall be mounted on 8 1/2" x 11" sheets annotated, explaining their purposed use.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Labels: All labels shall be permanent, and be machine generated. **NO HANDWRITTEN OR NON-PERMANENT LABELS SHALL BE ALLOWED.**
- B. Label size shall be appropriate for the conductor or cable size(s). All labels to be used shall be self-laminating, white/transparent vinyl and be wrapped around the cable or sheath. Flag type labels are not allowed. The labels shall be of adequate size to accommodate the circumference of the cable being labeled and properly self-laminate over the full extent of the printed area of the label.
- C. Nameplates: Engraved three-layer laminated plastic, white letters on a black background. Emergency system shall use white letters on red background.
- D. Stenciling: Black paint. Emergency system stenciling shall use red paint.
- E. Adhesive type labels not permitted except for phase and wire identification on circuits over 50V.

PART 3 - EXECUTION

3.1 GENERAL

- A. Clean all surfaces before attaching labels with the label manufacturer's recommended cleaning agent.

- B. Install all labels firmly as recommended by the label manufacturer.
- C. Labels attached to data or communication patch panels and face plates shall be installed plumb and neatly on all equipment.
- D. Install nameplates parallel to equipment lines.
- E. Secure nameplates to equipment fronts using screws, or rivets. Secure nameplate to inside of recessed panelboards in finished locations.
- F. Embossed tape will not be permitted for any application.
- G. Stenciling may only be used on equipment fronts in areas designated by the Architect/Engineer.

3.2 CONTROL WIRE IDENTIFICATION

- A. Provide wire markers on each conductor in panelboard gutters, pull boxes, outlet and junction boxes, and at load connection. Identify with control equipment number, input/output number, or with control wire number as indicated on schematic and interconnection diagrams, and equipment manufacturer's shop drawings for control wiring.

3.3 NAMEPLATE ENGRAVING AND STENCILLING

- A. Provide nameplates or stencils to identify all control equipment, and field devices served. Letter Height: 1/4 inch (6 mm) for individual switches and loads served, 1 inch (25 mm) for control equipment identification.

3.4 ELECTRICAL CONDUIT AND RACEWAY IDENTIFICATION

- A. Provide red colored conduit, fittings, conduit bodies and junction boxes for all fire alarm circuits. All junction boxes shall be labeled 'Fire Alarm'.
- B. Provide blue colored conduit, fittings, conduit bodies and junction boxes for all IT or telecommunications systems conduits. All junction boxes shall be labeled "IT".
- C. Provide yellow colored conduit, fittings, conduit bodies and junction boxes for all low voltage or security electronics systems conduits. All junction boxes shall be labeled "LVSE-xxxx" Where the 'xxxx' describes the system as indicated:
 - 1. ACS – Access Control systems.
 - 2. CCTV – Closed Circuit Television systems.
 - 3. IC – Intercom systems.
 - 4. NC – Nurse Call systems.
 - 5. PA – Paging systems.
 - 6. DS – Duress Alarm systems.
 - 7. PLC – Programmable Logic Control systems.
 - 8. TS – Touchscreen systems.
- D. Where existing branch circuit and feeder circuit conduit is re-used for the systems indicated above, the fittings and junction box covers shall be painted the color identified above.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Applicable provisions of Division 1 shall govern all work under this Section.
- B. Section Includes:
 - 1. System Software.
 - 2. System Programming.
 - 3. Access Control Panels.
 - 4. Entry Devices.
 - 5. Identification Cards.
 - 6. Door Contacts.
 - 7. Electronic Locking Hardware.
 - 8. Exit Control Devices.
 - 9. Alarm Monitoring Modules.
 - 10. Output Relay Modules.
 - 11. Motion Detectors.
 - 12. Elevator Control Modules and Elevator Readers.
- C. Related Sections: The Basic Low Voltage Requirements, Section 28 00 00, are part of this Section, and the contract for this work, and apply to this Section as fully as if repeated herein.

1.2 SYSTEM DESCRIPTION

- A. Provide a complete and operable Access Control System (ACS) complete with necessary processor modules, power supplies, communications modules, input and output modules, memory modules, mounting chassis and racks, enclosures, interconnecting cabling and/or bussing, and system programming.
- B. Provide all necessary interfacing and interconnection with other low voltage systems described in these specifications. Provide all auxiliary equipment necessary for complete functioning of all low voltage systems.
- C. The design of the System shall include devices and equipment used to monitor and control access to restricted areas, detect and deny unauthorized entries within specific areas, generate reports, produce Photo ID badges and annunciate alarms. The System shall be designed to provide operational flexibility and reliable performance.
- D. The System shall be modular, allowing for incremental expansion or modification of inputs, outputs, and remote control stations.
- E. All software shall be formatted, installed, and programmed in compliance with the Contract Documents and the recommendations of the Manufacturer.

1.3 REFERENCES

- A. Referenced standards and recommended practices referred to herein shall be the latest edition or revision of the referenced document.
- B. Systems shall be designed, manufactured, tested and installed in accordance with NFPA 70 (National Electrical Code), state codes, local codes, requirements of authorities having jurisdiction and in particular:

1. BOCA requirements
 2. NFPA 101 (Life Safety Code)
 3. Americans with Disabilities Act (Public Law 101-336)
 4. Manufacturer requirements
 5. Standard industry practices.
- C. Equipment and materials for which there are UL standard testing requirements, listings, and labels shall be listed and labeled by UL.
- D. System shall conform to UL 294 Access Control Systems and UL 1076 Line Supervision.

1.4 SUBMITTALS

- A. Submit product data under provisions of Section 17010 and Division 1.
- B. Submittals for Approval:
1. Include dimensioned shop drawings and wiring diagrams.
 2. Product Data: Provide data sheets, dimensions, ratings, performance data, and accessory information for each type. Product data shall include, as a minimum, information on the following:
 - a. Each controller, module, and interface unit.
 - b. System topology.
 - c. Proximity Card Readers
 - d. Proximity Cards.
 - e. PIR Motion Detectors.
 - f. SQL based database.
 - g. Network and Workstation Environment Software.
 - h. Server and Workstation Hardware.
 - i. Power Supplies.
 3. Shop drawings: Include point-to-point wiring diagrams for each building. Point-to-point diagrams shall detail each device location and all associated wire runs. Provide with the shop drawings a separate layout drawing for each equipment panel, rack, cabinet and control unit on the project. The panel layout drawings shall show each component and shall detail the wiring for all devices connected to all components within the rack or panel. They shall show the labeling of each terminal strip connection point, each wire connected to the connection point and each cable leaving the rack or panel. The layout drawings shall indicate in detail the labeling of each component within the panel including power supplies, terminal strips, switches, card cages and plug-in modules.
 4. Where AC or DC power supplies are used for Class 1, 2, or 3 Power-Limited Circuits, the Contractor shall provide evidence that the power capacity is sufficient for the proper operation of the powered devices under maximum load. Detailed calculations of the power requirements shall be acceptable for this purpose.
 5. System Response: Provide a detailed analysis showing the maximum system response time.
 6. This system includes interfacing and interconnection with other low voltage systems described in this specification. Verify the requirements for these interfaces and provide auxiliary equipment necessary for complete functioning of all systems. Systems that require interface include:

- a. PLC Door Control System.
 - b. Touchscreen Control System.
 - c. Closed Circuit Television System.
 - d. Intercom System.
 - e. Optical Turnstile System.
 - f. Strategic Offender Management System.
 - g. Vehicle Gate System.
- C. Submittals for Close-Out:
- 1. Product Data: Provide updated information for all Product Data.
 - 2. As-Built Drawings: Provide updated information for the Shop Drawings.

1.5 REGULATORY REQUIREMENTS

- A. Equipment shall be assembled of UL listed materials.

1.6 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in manufacturing the System specified in this section with minimum 10 years documented experience.
- B. Installer
- 1. The Contractor shall be regularly engaged in providing security equipment and security related services and shall have been engaged in such work for a period of not less than 7 years prior to bid submittal.
 - 2. The Contractor shall, at the time of the bid, be licensed by the State or local jurisdiction to perform security work within the state. Contractors who have security licenses or permits pending shall not be considered acceptable for bidding on this project.
 - 3. All personnel employed by the Contractor shall be registered with the State or local jurisdiction Systems Licensing Board as provided for by current state statutes.
 - 4. Each Contractor submitting a bid for this project shall include with his bid a copy of his current alarm system license as issued by the State or local jurisdiction Licensing Board.
 - 5. The Contractor shall, at the time of the bid, be licensed by the State or local jurisdiction as an Electrical Contractor in the SP-LV, Limited, Intermediate, or Unlimited classification.
 - 6. Each Contractor submitting a bid for this project shall include with his bid a copy of his current Electrical Contractor license as issued by the State or local jurisdiction Board of Examiners of Electrical Contractors.
 - 7. The Contractor shall, at the time of the bid, provide satisfactory evidence of liability insurance and Workmen's Compensation coverage for employees as required by law.
 - 8. The Contractor shall be prepared to provide upon request the name and location of a similar project which would be available for inspection by the owner or his representative in order to verify the competency of the Contractor to perform within the scope of this project.

1.7 WARRANTY

- A. The Contractor shall guarantee all wiring and equipment for this system to be free of defects in workmanship and material for a period of one (1) year from the date of acceptance by the Owner.
- B. The Contractor shall provide to the Owner's Representative a preventative maintenance contract with 48-hour guaranteed emergency response service at the time of system acceptance. 48-hour emergency response service shall be applicable during normal contractor working hours. Eight-hour emergency response service shall be provided during after-hour and weekend periods. This contract shall be provided at no additional charge to the Owner for the first year.
- C. The Contractor shall, at the time of bidding, include the cost of a full-coverage preventative maintenance contract similar to the above for the second year as separate line item option.
- D. The Contractor shall, as part of the maintenance contract, guarantee that an adequate stock and supply of replacement parts for the systems shall be maintained at the Contractor's nearest place of business. The Owner may, at the Owner's discretion, elect to maintain additional or supplementary inventories of spare parts.

1.8 EXTRA MATERIALS

- A. Provide maintenance materials under provisions of Section 01700.
- B. Provide 10% of each type switches, pushbuttons, LEDs used with a minimum of one (1) of each type listed in Section 2.
- C. Ten percent (10%) of the number used of each type module (one each minimum).
- D. One power supply of each type used on this project.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Environmental ratings for all components of the ACS system, except programming equipment, shall meet or exceed the following requirements:
 - 1. Ambient Temperature rating of 0 to 60 C (32 to 140 F) operational and -20 to 70 C (-4 to 158 F) storage.
 - 2. Humidity rating of 10% to 90% Relative Humidity (non-condensing).
 - 3. All system modules shall be designed so as to provide for free airflow convection cooling. No internal fans or other means of cooling except heat sinks, shall be required.

2.2 MANUFACTURERS

- A. The system shall be as manufactured by Sielox to match existing campus infrastructure.

2.3 ACS SYSTEM COMPONENTS

- A. The System shall provide integrated access control and security management functions, according to location of access points, alarm input and output points, time of day, day of week, day of year and personnel.

- B. The System shall allow the incorporation of networked Workstations.
- C. System administration and programming operations shall be available from any Workstation on the System.
- D. The System shall provide elevator control which will permit the restriction of cardholder access to floors while also allowing general access to other floors. The elevator control software shall allow the use of any card reader.
- E. The System shall offer dial-up communication from the System Server to multiple network control panels utilizing industry standard baud rate via US Robotics Sportster Modems as a communications method.
- F. The System shall offer TCP/IP-based network communication from the System Server to the primary control panel of each loop utilizing industry standard Ethernet technology as a communications method.
- G. Access Control Panel (ACS)
 - 1. The System shall consist of Sielox Systems controllers (also designated the "500 series" controllers). The controllers shall be micro-processor based control unit(s) with all access and I/O decisions to be made by the individual controller(s). The controllers shall be of modular design which will allow for present security requirements and the capability to expand. All field controller panels shall be configured to intercommunicate via RS-422 hardwired or fiber-optic communication.
 - 2. All field controllers shall be equipped with a tamper contact.
 - 3. One controller per loop shall be designated a "Primary", responsible for all PC-to-loop communications.
 - 4. All other controllers (up to a maximum of 254 per loop) shall be designated "Secondaries" and shall communicate with the "Primary" via an RS-422 network or fiber-optic configuration.
 - 5. All controllers shall have built-in surge suppression circuitry on plug-in modular circuit boards (Dual Port Interface). This surge protection, designed as an integral component of the system, shall be self-sacrificing in the event of extreme surges or spikes. No external surge suppressors shall normally be required.
 - 6. Each Model 508 controller shall be capable of supporting at least two ports and be expandable in increments of two ports up to a maximum of eight ports per controller. Each Model 502 controller shall support up to two ports per controller. A Dual Port Interface board will be required to activate any pair of ports on any controller.
 - 7. Each port shall be configured by software to support any one of the following peripheral devices: Card reader, Alarm Monitoring Module, Output Relay Module, Elevator Reader, or Elevator Output Module. Any combination of these devices can be supported on each controller, up to a total of 8 devices per Model 508 controller or 2 devices per Model 502 controller.
 - 8. Each controller shall have the capability of supporting multiple card reader technologies simultaneously, including Transmissive Infrared, Wiegand, Magnetic stripe, Proximity, Barcode, Keypad, Card/Keypad, Smart Card, and Biometrics. This capability is an integral part of the system and does not require special external equipment.
 - 9. Each controller shall have built-in battery back-up of programmed information and shall be sustainable for a period of not less than ninety days.

10. Each controller shall be powered by a 12VDC power source rated at a minimum of 2 amperes. This power supply shall have a battery back-up for complete system operation in the event of power failure. Provide battery backup for all controller panels shall be sufficient to power the panel for 48 hours continuous service.
11. Electric strikes or other locking devices shall have a separate power supply. Battery back-up shall be utilized for continued operation in the event of power failure.

H. Identification Cards

1. Provide QUANTITY passive proximity access cards constructed of thin, flexible polyvinyl chloride (PVC) laminate and capable of direct print with new generation photo imaging printers. An external number shall be provided on each card for identification and control. The proximity card shall be HID ISOProx Proximity Access Card.
2. The card shall be pre-fabricated, credit card size, generic 26 Bit proximity card constructed of molded plastic. A punched slot shall be provided for a strap or clip. The card shall be capable of having multi-color custom graphics.
3. Numbering sequence shall be [xxxx] to [xxxx].

I. Alarm Monitoring Modules

1. Each Alarm Monitoring Module shall support up to 16 input devices as well as inputs dedicated to monitoring enclosure tamper, auxiliary AC failure and communication failure conditions. Removable two-part connectors shall be used for easy installation and maintenance.
2. The Alarm Monitoring Module (AMM) shall support both Normally Open and Normally Closed inputs. Full input supervision shall allow detection of ALARM, SAFE, TROUBLE OPEN and TROUBLE SHORT circuit conditions. Supervision type shall be selectable for each AMM, and the supervision type does not have to be consistent system wide.

J. Output Relay Modules

1. Each Output Relay Module shall provide 16 individually-addressable relay outputs. Each relay shall provide both normally open and normally closed contacts.
2. Communication failure, AC Failure and tamper conditions shall be monitored as alarm conditions for each Output Relay Module.

2.4 FIELD EQUIPMENT

A. Entry Devices

1. Standard Range Proximity Card Readers: Provide and install a proximity card reader at each of the card access doors indicated on the drawings. The reader shall be designed to mount on a single gang electrical box. The reader shall be designed for indoor/outdoor, Wiegand 85 bit output and white in color. When used with HID ISOProx II cards, the reader shall have a read range of 5". The reader shall be HID Thinline II Proximity Reader.
2. Long Range Proximity Card Readers: Provide and install a proximity card reader at each of the card access doors indicated on the drawings. The reader shall be designed to mount on a single gang electrical box. The reader shall be designed for indoor/outdoor, Wiegand 85 bit output and

- black in color. When used with HID ISOProx II cards, the reader shall have a read range of 20". The reader shall be HID MaxiProx Proximity Reader.
3. A Reader/Keypad shall indicate power to the reader. When a proximity card is presented to the reader, the Reader/Keypad shall flash Green and the beeper shall sound briefly indicating to the cardholder that the card was read. A longer duration flash and beep shall follow for an authorized card.
- B. Exit Control Devices
1. Reference Section 28 05 20 Low Voltage Devices.
- C. Elevator Control Modules and Readers
1. Provide and install for each elevator car an elevator control module with the ability to integrate with the Sielox access control system. The modules shall be housed in a tampered steel cabinet with provisions for conduit connection. The modules shall communicate with the appropriate Sielox controller via a 22AWG 6 conductor cable with overall shield.
 2. Security Contractor shall coordinate with the Elevator Contractor to interconnect the Sielox elevator control modules with the appropriate elevator controls.
 3. Provide a 22AWG, 8 conductor, shielded, twisted cable to the Elevator Contractor. This cable will be used as the traveler cable which shall interconnect the proximity card reader to the Sielox controller. The cable shall be installed by the Elevator Contractor. Security Contractor shall coordinate with Elevator Contractor to assure the specified cable meets all code requirements.
 4. Power for each module shall be provided by a low-voltage 12VDC plug-in power supply.

2.5 SYSTEM FUNCTIONS

- A. The System primary functions shall be to regulate access through specific doors to secured areas, regulate elevator control and monitor alarm points.
- B. The System shall also provide for a credential creation and production system integrated with the cardholder management system.
- C. The System shall utilize a single database for both its access control and photo imaging functionality. This integration shall be provided under one operating environment.
- D. The System shall be able to control up to 2,040 doors, 32,640 alarm inputs, or 32,640 relay outputs or any combination of these components per loop.
- E. The System shall support configuration and simultaneous monitoring of multiple loops when TCP/IP connections are used between the PC and the Primary Controller of each loop. The events of those sites shall be viewable as separate loops or as a combined list of all events.
- F. Overall control of the access control, alarm monitoring, and photo-imaging shall be through software control.
- G. The System shall provide a real-time display of all system events.
- H. The System shall archive all events in a database stored either on the local hard drive or a network database server.

- I. The System shall be expandable in small modular increments up to the total system capacity.
- J. The System shall allow the configuration of networked workstations. The workstations and file server shall be connected via a TCP/IP network.
- K. The System Workstations shall be able to monitor field hardware devices, such as card readers and field controllers. Administrative tasks such as assigning areas, schedules, report generation, displaying color graphic maps, etc. shall be provided from any workstation on the network.
- L. All system programming data shall reside on a single database and shall be instantly accessible to every Workstation connected to the network.
- M. The system shall utilize a non-proprietary SQL-based, ODBC-compliant database, managed by Sybase Adaptive Server Anywhere, Microsoft SQL Server, or Oracle.
- N. The System shall utilize a preemptive multi-tasking operating system: Microsoft Windows NT, Windows 2000, or Windows XP environment. The System shall be designed to utilize the capabilities of multitasking operation, with many processes running at the same time without interference with each other and with higher priority tasks taking precedence over lower priority tasks.
- O. The System shall support responses to alarms entering the system. Each alarm shall be capable of initiating one or more of the following actions: sending alarm commands to a CCTV system interface, triggering DVR event recording, activating output devices, playing PC audio files, controlling doors, and displaying floor-plan graphics associated with the alarm device.
- P. The System Access control functions shall include validation based on time of day and day of week, special day/holiday scheduling with card validation override, video image storage and retrieval of cardholder photographs, access validation based on positive verification of card, card/PIN, card and video.
- Q. The system shall provide both supervised and non-supervised alarm point monitoring.
- R. The system shall be capable of arming or disarming alarm points both manually and automatically by time of day, day of week or by operator command. The system shall be capable of disarming alarm points based on a valid access event.
- S. The system, when used for elevator control, shall grant access to elevator floors based on a valid credential, or by schedule.
- T. The system shall report alarm point activity or status. The reporting shall notify of 'Alarm', 'Normal', or 'Trouble' conditions.
- U. The system shall provide mode of system operation that requires operator acknowledgment of any alarm.
- V. The system shall provide programmable 'delay' setting for all system alarm points. The system shall not report an ENTRY type alarm condition until the delay setting has expired. The system shall not report a DWELL type alarm condition until the alarm has been active for the full delay period.
- W. The system shall include fully integrated badging capabilities, including image capture, image editing, badge design, and badge printing. The system shall permit the storage of four different images: main photograph, alternate photograph,

signature, and fingerprint. The system shall allow each cardholder to be assigned to both a badge design formatted for badge printing and a dossier design formatted for standard paper printing.

- X. The system shall provide for interfacing with external badging programs, in which stored photo images are displayed in cardholder information window but other badging features are supported by the external program.
- Y. The Photo-imaging components shall include one or more workstations at which all of the required image capture equipment has been installed.
- Z. The system shall provide capability to place control panels in an off-line mode. In the off-line mode, the control panels shall retain a historical summary of all control panel activity transactions, up to the maximum capacity of the control panel memory buffer.
- AA. The system shall provide ability for manual operator control of system output relays. The manual functions shall include the ability to energize, de-energize, enable or disable.
- BB. The system shall provide ability to display stored 'video image' of cardholder based on card activity, and switch real-time camera to card reader location for specific card usage. The card reader shall not activate the door lock until positive operator acknowledgment.
- CC. Equipment repair shall be accomplishable on site, by module replacement, utilizing spare components.
- DD. The system software shall be capable of, but not limited to, the following programming:
 - 1. Time Schedules: Up to 254 user-definable time schedules shall be provided per loop. These time schedules shall determine the day(s) and times that access will be granted or a scheduled event shall occur. Any and all of the time schedules shall be available for defining access privileges and scheduled events. There shall be ALWAYS and NEVER schedules that cannot be altered or removed from the system. Each user-defined time schedule shall have the option of reacting or not reacting to user-defined special days, with the ability to react uniquely to each type of special day.
 - 2. Special Days: There shall be an unlimited number of user definable special days. These days shall be used for configuring exceptions to the normal operating rules, typically for specifying holiday operating rules. Each special day shall be assigned to a type, with each type defined by the user.
 - 3. Controller Daylight Savings Time Adjustment: There shall be a software-configurable, user defined adjustment for Daylight Savings Time. The controller shall not need to be connected to a PC in order for the adjustment to occur.
 - 4. Log Buffer: There shall be a minimum of an 10,300 event log buffer per controller. The log buffer shall be used to record and hold access and alarm activity information until the Personal Computer is connected and receives the information. There shall be a software-configurable warning notification of log buffer filling for controllers configured with modem capabilities.
 - 5. Scheduled Events: Any access controlled point shall be capable of scheduled unlock periods to allow for card-free access. The access controlled point shall also be capable of requiring one valid access event

- before beginning a scheduled unlock period. Additionally, any access control point shall be capable of requiring a valid card as well as a PIN code on a scheduled basis for high security areas. The use of PIN functions shall not reduce the number of card reader or alarm points available in the controllers. Any designated alarm input shall be able to be scheduled Armed and Disarmed. Any relay output shall be capable of scheduled On and Off periods to allow for automatic I/O system control.
6. Operator Privileges: An unlimited number of system operators shall be supported, each with a unique login and password combination. Operators shall be assigned privileges based on the loops, commands, or programming features that are available to each individual operator.
 7. Maximum User Capability: Up to 64,000 individual users per loop may be given access cards or codes and have their access controlled and recorded.
 8. Access Groups: Each system user shall be assignable to a maximum of four of 256 possible access groups per loop (254 of which may be user defined). An access group shall be defined as one or more people who are allowed access to the same points at the same days and time periods.
 9. Active/Expire Dates: Any card/user may be configured with activation and expiration dates. The card can be assigned to any valid access group and will be activated and expired according to the specified dates.
 10. Maximum Use Settings: Any card/user may be configured with maximum number of uses for that card. The card can be assigned to any valid access group and will be expired according to the specified number of card uses.
 11. Door Outputs: Each access control point shall have two dedicated relay outputs. Both relays shall provide Normally Open and Normally Closed contacts. The first relay shall be used for electric lock control. The second shall be software configurable to activate for door forced open, door left open too long, duress, passback violations, invalid access attempts and valid unlock conditions. Both relays shall be separately programmable for energize times from 1 second to 10 minutes and 45 seconds. Relay 2 shall also allow a delay time to be specified, causing its activation to be delayed after the activating condition occurs.
 12. Anti-Passback: The system shall have global anti-passback capability. Any door on the system can be linked to one of 254 user defined passback areas or two (2) pre-defined areas. Each door may be set up to automatically forgive passback entries at the following intervals: Never, at Midnight, every 12 hours (Midnight and Noon), every 6 hours, every 2 hours, each hour or every 30 minutes. Each door can be configured to deny or grant access for passback violations and individual users can be exempt to the passback rules. The anti-passback features shall be loop-wide and operate completely independent of the PC with the exception of configuring the passback rules. Additionally, the operator shall have the ability to manually forgive an individual user or all users by command from the PC.
 13. Two Person Rule: Any access control point on the system shall have the ability to require two valid cards for access. This feature shall be software programmable. Any access control point on the system that includes a keypad shall also have the ability to require a valid PIN number associated with each of the two valid cards.
 14. User List/Who's In (Muster Reports): The system shall be capable of generating dynamic lists of users in certain access-controlled areas, based either upon selected users or selected areas. The lists shall have the option of automatically refreshing after a user-selected interval of time.

15. Crisis Mode: The system shall support “crisis mode”, in which the activation of user-selected alarm points causes changes to user access privileges.
16. Door Groups: The system shall allow up to 255 door groups per loop to be configured. Doors belonging to the same group shall be able to be locked, unlocked, disabled and enabled on command from the PC.
17. Door Interlocking: The system shall allow a group of doors to be software configured so that if any door in the group is unsecure, all other doors shall be automatically disabled. This feature also known as “mantrap” configuration. The interlocking features shall be loop wide and shall not require the PC to be on-line for proper operation.
18. PIN Required: The system shall support the required use of a keypad code, in addition to a valid credential, at user-selected doors, during user-selected schedules.
19. Remote door control: The operator shall have the capability of manually controlling any access point by issuing a simple command from the PC. The operator shall have the ability to lock, unlock, enable, disable and pulse any door in this manner. This activity shall cause an entry to be logged displaying the door name, number and time that it was performed. Additionally, the operator shall have the ability to lock, unlock, enable and disable any group of doors in a Door Group by a single command from the PC.
20. Key Control: When interfaced with an approved key-control system, the system shall allow users to deny access to certain doors to any users who have keys in their possession.
21. Guard Tour: The system shall support user-defined guard tours. The tour may be configured in a set pattern of tour points, or may follow a mode in which all tour points can be visited in any order within an allotted time. The system shall allow a tour to be started by PC-command, by use of a selected card at a selected reader, or by use of a selected keypad code at a selected keypad. The system shall detect guard late-to-point, point missed, and point out-of-sequence events. The system shall generate a report at the completion of a tour.
22. Reader Disable: The system shall support disabling readers in reaction to a user-selected number of invalid access attempts.
23. Disable Event Messages: The system shall allow users to disable user-selected event messages (Door Forced Open, Door Open Too Long, Door Closed, Request to Exit) for user-selected doors. The system shall allow users to disable certain messages (Door Forced Open, Door Open Too Long) according to a user-selected schedule.
24. I/O Groups: The system shall allow up to 255 user-defined I/O (input-output) groups to be defined per loop. Each Input device shall be able to be linked to these groups for arming, disarming, shunting and unshunting as well as output control.
25. Alarm Priorities: Each alarm device shall have the ability to be user configured to belong to one of 10,000 priority levels. Priority levels are numbers assigned to an alarm based on the importance of the alarm. 9,999 is the highest and most critical level of alarms. Zero is the least significant.
26. Delays: Each alarm device shall allow a delay to be specified. The delay shall be either an entry type or a dwell type. An entry-type delay shall prevent the input from issuing an alarm event until the delay elapses. If unarmed during the delay period, the alarm condition shall be ignored. A dwell-type delay shall require the input to remain in the alarm state for the full duration of the delay before issuing an alarm condition.

27. Remote Input control: The operator shall have the capability of manually controlling any alarm/input point by issuing a simple command from the PC. The operator shall have the ability to shunt, unshunt, disable and restore any input in this manner. This activity shall cause an entry to be logged displaying the input name and time that it was performed. Additionally, the operator shall have the ability to arm, disarm, shunt and unshunt any alarm partition/group by a single command from the PC.
28. Output Configuration: Each output relay shall be software configurable as a FOLLOWS, LATCH, TIMEOUT, SCHEDULED, or TIMEOUT RETRIGGERABLE type. The SCHEDULED type shall allow a time schedule to automatically control its activation and de-activation. The FOLLOWS, LATCH, TIMEOUT, and TIMEOUT RETRIGGERABLE types shall be configured to activate based on the condition of I/O groups. Additionally, a time schedule shall be specified to configure when the output shall actively monitor the I/O groups.
29. Remote Output control: The operator shall have the capability of manually controlling any output point by issuing a simple command from the PC. The operator shall have the ability to ENABLE, DISABLE, turn ON and turn OFF any output in this manner based on the output type. A FOLLOWS type output shall not be capable of being turned OFF or ON. This activity shall cause an entry to be logged displaying the output name and time that it was performed.
30. Remote Reset Command: Any controller shall have the capability of being reset manually or by command issued from the server PC with which it is communicating. This reset command shall have the option of simulating the controller reset settings, or forcing a reset type as specified by the user.
31. Dial Out: The controller shall have the capability of using a modem or TCP/IP network connection to automatically connect to the server PC when a critical alarm or service event occurs. The conditions triggering the dial out capability shall be user defined and software configurable.
32. Loop Time Zone: The software shall allow the user to select the time zone in which the loop is located, so that event times displayed for that loop will match the local time where the loop is located.
33. User-Selected LED Behavior: The software shall allow the user to select different behaviors for the LEDs of readers in each loop.
34. Traced Cards: The software shall be capable of selecting any number of cardholders for the purpose of limiting reports to only traced users. The software shall be capable of displaying all traced cardholder events in a user-selected alternate color.
35. Reports: The software shall include integrated reporting capabilities as well as the ability to run Crystal Report templates.
36. Badge Print Tracking: The software shall support setting a print limit for any badge. The software will track the number of times any badge has been printed, as well as display the date and time of the most recent printing.
37. User Interface: The system programming shall be menu-driven, with "wizards" to assist with system software configuration, and shall include on-line 'Help' information.
38. System Messages: The system shall permit the use of user-selected colors for event messages.
39. Graphics: The system shall be capable of displaying a floor-plan graphic for card activity and alarm events.
40. Device Status: The system shall be capable of displaying the dynamic status of a user-selected list of devices, including doors, inputs, and outputs.

41. Loop Diagnostics: The system shall include diagnostic software tools that interface with the system hardware to query the hardware for information and to issue commands to the hardware.
42. Mandatory Data Fields: The system shall allow any cardholder data field to be selected by the user as mandatory.
43. User Defined Data Fields: The system shall provide 20 unassigned cardholder data fields for storing user-defined data. The data fields shall support user-defined labels, and shall be user-configurable as plain text fields or drop-down selection lists.
44. Archive Database: The software shall include a connection to an archive database, which stores purged events and deleted programming, and which can be accessed for reporting.
45. Programmable Database Backup: The software shall include the capability of performing user-scheduled database backups, without the use of third-party backup software, when using the default Sybase database.
46. Programmable Database Purging: The software shall include the capability of performing user-scheduled database purging, moving selected events to the archive database when the events have aged a user-specified number of days.
47. Database Importing: The software shall include the capacity to import user data from an ODBC datasource (Access, Excel, text) into the Sielox database.
48. Data Exporting: The software shall include the capacity to export data from any table in the database to either a text or HTML file, in any user-selected order.
49. Event Log Output: The software shall include the capacity to send a continuous stream of user-selected types of event messages to a text file, serial port, or TCP/IP address.
50. Data Audit Trail: The system shall record changes to system programming, recording the date/time stamp of the change, the name of the operator making the change, and the nature of the change. This data audit shall be available in history reports. The system shall permit users to select types of changes that will not be recorded in the audit.
51. Automatic Reconnect: The system shall automatically attempt to reconnect to the hardware after a user-selected time period if a disconnect is detected. The automatic reconnect will warn the user before attempting the reconnect, and will include suggested reasons for the disconnect. The automatic reconnect will also allow the user to interrupt or cancel the reconnect attempt.

2.6 AUXILIARY EQUIPMENT

- A. Power Supplies: UL approved power supplies providing sixteen (16) 24VDC non-power limited outputs, individually fused at 3.5A each. Altronix #AL1024ULXPD16 or approved equal.

2.7 WIRE AND CABLE

- A. Data wiring to proximity card readers shall be 5 conductor #22 with overall shield, Alpha Wire and Cable #1295C or approved equal. LED/Tone control wiring to proximity card readers shall be 7 conductor #22 with overall shield, Alpha Wire and Cable #1297C or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation of the System shall include the appropriate equipment and shall be performed by a factory-trained Sielox Certified Dealer. The installation shall be completed to these specifications and project plans as required by the Owner. The installation shall include the following:
- B. Project planning and system configuration of field hardware and head-end equipment.
- C. Complete hardware set-up and configuration of all system Workstations and peripherals.
- D. Set-up of specific network software configuration requirements.
- E. Badge design (where badges are required).
- F. Complete system diagnostics and operation verification.
- G. Completion of specific customer acceptance test plans.

3.2 INSTALLATION PRACTICES

- A. The Contractor shall provide, in accordance with individual manufacturer's instructions, the installation of all equipment specified within this section of the specifications and/or shown on the associated drawings unless specified as being installed by others.
- B. The Contractor shall provide all conduit, wiring, 120 VAC power extensions, terminations, materials, and connections to all equipment unless specified as being provided by others.
- C. All wiring and cabling shall be in conduit. Color-coding shall be used throughout for all wiring and cabling.
- D. Electric door hardware for card reader doors shall be furnished and installed by the Security Contractor unless otherwise specified.
- E. All boxes and enclosures containing security system components and/or cabling and which are easily accessible to employees or to the public shall be provided with a lock. Boxes above ceiling level in occupied areas of the building shall not be considered to be accessible.
- F. All junction boxes and small device enclosures below ceiling level and easily accessible to employees or the public shall be covered with a suitable cover plate and secured with tamper proof screws.
- G. All exposed metallic flexible conduit and armored cable shall be dressed down neatly and secured with low profile, metal fasteners.
- H. A separate suitable ground wire shall be connected to all lightning protection devices installed. The ground wire shall be connected to the nearest point of the building grounding system and bonded to it. All devices shall be provided with suitable grounding or lightning protection as recommended by the manufacturer. All drain wires on shielded cables shall be utilized and dressed down appropriately.
- I. End-of-Line resistors shall be installed at the field device location and not at the controller panel location.

3.3 SYSTEM LABELING

- A. The Contractor shall provide all labeling and numbering required for all components and wiring for the project.
- B. Each terminal strip and screw terminal in each cabinet, rack or panel shall be individually labeled.
- C. All wiring conductors connected to terminal strips shall be individually numbered and each cable or wiring group being extended from a panel or cabinet to a building mounted device shall be identified with the name and number of the particular device as shown.
- D. Each wire connected to building mounted devices shall not be required to be numbered at the device if the color of the wire is consistent with the associated wire connected and numbered within the panel or cabinet.

3.4 SYSTEM SOFTWARE

- A. The Contractor shall provide the development, loading and checking of the software and/or databases for the complete and proper operation of the systems involved. When the Contractor is required to provide software, it shall be of the most current type and revision. Where licensing of the software is required, the license shall be assigned to the Owner, unless specifically prohibited by the software manufacturer. The Contractor shall provide a copy of the software on media to the Owner prior to system acceptance.
- B. Prior to performing any programming, the Contractor shall coordinate with the Owner and shall obtain the Owner's specific programming requirements. The Contractor shall advise the Owner in writing, of the scheduled date for commencement of programming. The Contractor shall provide the Owner the opportunity to assist in development of programming details.

3.5 SYSTEM TESTING

- A. Site tests shall be performed by a factory trained field technician with the Owner's Representatives in attendance.
- B. Tests shall be performed on each circuit and component of each system. Tests shall include, but not be limited to, measurements of power supply output under maximum load, signal loop resistance, and leakage to ground where applicable. System components with battery backup shall be operated on battery power for a period of not less than 10% of the calculated battery operating time. Where testing components requires special or dedicated equipment, the equipment shall be provided by the Contractor.
- C. On any circuit where malfunctions occur, each component within the malfunctioning circuit shall also be retested after the malfunction has been corrected.
- D. Each circuit or component that could possibly be related to the malfunctioning circuit shall also be retested.
- E. A report shall be given to the Owner at the completion of each day's testing outlining the tests performed and verifying the completion or problems incurred with each test. The report shall be prepared by the security Contractor's technical personnel after each days testing is complete.

- F. The Contractor shall continue the test procedures until all devices and sequences are complete and functioning properly and until all system testing has been completed.
- G. The Contractor shall demonstrate to the Owner's Representative that all sequences operate correctly and that all products, devices and system software operate as designed and specified.
- H. As-built drawings shall include all shop drawings previously submitted. The drawings shall include all wiring and labeling as it was actually installed. Any equipment changes made during the project shall be noted.
- I. Documentation of testing shall be included in the As-built package.

3.6 TRAINING AND SYSTEM ACCEPTANCE

- A. A training session, being a minimum of two (2), four-hour (4) sessions in length for the card access and security system and for the CCTV system, shall be held by the Security Contractor at the job-site at times mutually agreed upon between the Owner and the Contractor. Two (2) basic system operations manuals shall be supplied to the Owner at no additional cost. Those attendees who will be responsible for day-to-day maintenance shall also receive additional training and an Operation and Maintenance (O&M) Manual. Two (2) O&M manuals shall be provided to the Owner at no additional cost to the Owner.
- B. The manufacturer's standard catalog cut sheets shall not be acceptable for use as O&M manuals.
- C. Field set-up time, start-up time, and testing time shall not be considered as training time.
- D. The security system shall not be considered accepted until all punch list items have been corrected in all buildings. Beneficial use of part or all of the system shall not be considered as acceptance.

3.7 FIELD QUALITY CONTROL

- A. Quality control services include inspections and tests and related actions including reports, performed by independent government agencies, governing authorities, and the Sielox Certified Dealer. They do not include Contract enforcement activities performed by the Engineer.
- B. Inspection and testing services are required to verify compliance with the requirements specified or indicated. These services do not relieve the Sielox Certified Dealer of responsibility for compliance with Contract Document requirements.
- C. To the fullest extent possible, provide products of the same kind, from a single source, and from the same manufacturer.
- D. Where specifications describe a product assembly, listing exact characteristics required, without use of a brand or trade name provide a product or assembly that provides the characteristics or otherwise complies with Contract requirements.
- E. Where specifications require compliance with performance requirements, provide products that comply with these requirements, and are recommended by the manufacturer for the application indicated. General overall performance of a product is implied where the product is specified for a specific application.

- F. Comply with manufacturer's instructions and recommendations for installation of product in the applications indicated. Fasten products securely in place, accurately located and aligned with other work.
- G. The Sielox Certified Dealer is responsible to remedy defects due to faulty workmanship and materials with appear within one year from the date of acceptance in accordance with this agreement.

3.8 SYSTEM ACCEPTANCE TEST

- A. A phased acceptance test and performance demonstration program shall be developed and documented by the Sielox Certified Dealer under the direction of the Project Manager. These requirements shall apply to all system components and software, including, but not limited to all system host computers, field panels, card readers, key pads, Photo ID Badging peripherals, CCTV interface capability.
- B. The Sielox Certified Dealer shall perform the tests and document the results. Operational scenarios shall be developed and used by the Sielox Certified Dealer to simulate the actual use of the system in the normal environment of Owner facility.
- C. The Owner reserves the right to modify the Sielox Certified Dealer plan or develop new operational test and evaluation procedures to effectively document system operations.

3.9 SYSTEM DOCUMENTATION

- A. Complete documentation shall be provided with the system. The documentation shall completely describe all operations, each program, hardware and peripherals. All updates to documentation will be provided at no additional charge, in the same quantities as originally required.

3.10 MISCELLANEOUS CONDITIONS

- A. Provide all wiring, connectors, power supplies, interfaces, modems, and other hardware as necessary to effect an operating system.
- B. Provide conduit as necessary for interconnect equipment between the Access Control System and other low voltage systems.
- C. Provide and install tamper proof screws on all exposed boxes.
- D. All points and devices shall be wired to the local controllers as homeruns unless otherwise specified and agreed to. All terminations shall be made in a manner consistent with industry standards. All terminations to the controllers shall be made in a manner recommended by the manufacturer and shall meet the approval of the owner as a condition of the acceptance of this project. Compression type terminal strips shall be used whenever terminations are made at points other than on the components. There shall be no splices in any cable except where necessary to interface with pre-wired devices. The Sielox Certified Dealer shall be responsible for all materials and labor necessary to replace cables which have been installed improperly or damaged in installation. Repairs to damaged cables or extending cables by splicing will not be permitted.
- E. All programming of the security system and system components necessary to provide a fully operational system shall be included in the scope of this work. All Alarm graphics maps shall be programmed and generated by the Sielox Certified

Dealer to the satisfaction of the owner. CAD files will be supplied to the Sielox Certified Dealer if requested.

- F. These specifications and the drawings submitted with the specifications represent an outline of the system that is desired. The compatibility of the equipment described is the responsibility of the contractor submitting the proposal. It has not been intended to list all parts, interfaces, and miscellaneous equipment that may be needed; it is the responsibility of the contractor submitting the proposal to provide the equipment necessary to provide a properly operating system.
- G. Where existing conditions require additional work or coordination with other contractors, such as existing door hardware, conduit, or door framing, coordinate exact installation with the owner prior to proceeding.
- H. Battery backup for all card access controllers shall be installed and provide no less than 48 hours battery backup service. This shall supply all necessary power for proper operation of the card access door.
- I. Any firewall penetrations shall be sealed with 2-hour intumescent UL approved fire-stop material.
- J. Any holes or visible damage created while retrofitting hardware will be properly corrected and patched to the Owner's satisfaction.

3.11 WIRING INSTALLATION

- A. Provide all wire, cable, terminal blocks, and fittings.
- B. Provide terminal strips or connectorized plugs for connection of all incoming field wiring. Terminate all wiring on terminal blocks for connection to field wiring. Label all terminal strips to coordinate with installation drawings.
- C. All wiring shall be bundled and secured to minimize tension on wiring device terminations.
- D. All low voltage wiring in consoles shall be Class 1 or Class 2 power limited circuitry in strict accordance with NEC Article 725 except power cords for amplifiers, monitors, etc. Maintain separation of conductors as required.
- E. Wiring system shall be Class 1 for both control and indication. Wiring from control panel to equipment cabinet may be Class 2. Maintain separation of conductors per NEC Article 725.

3.12 TESTING

- A. Verify unhindered operation of the security control electronics during power loss, transfer to emergency back-up generators and re-transfer to normal power. Verify unhindered operation of the security control electronics during main CPU fault or shutdown where a hot-standby CPU is indicated.
- B. Intentionally simulate a controller fault and verify orderly shut-down of functions and indication of maintenance alarms.
- C. Document all test results on forms approved by the Owner.
- D. Test completed control panels for operability in accordance with other Sections of this Specification.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Applicable provisions of Division 1 shall govern all work under this Section.
- B. Section Includes:
 - 1. Camera Enclosures and Mounting.
 - 2. Dome Cameras.
 - 3. Matrix Switchers.
 - 4. Network IP Based Digital Video Management Software (NVMS) System
 - 5. Monitors.
 - 6. Video Accessories.
 - 7. Cabling.
 - 8. System Software.
 - 9. System Programming.
- C. Related Sections:
 - 1. The General Low Voltage Requirements, Section 28 00 00, are part of this Section, and the contract for this work, and apply to this Section as fully as if repeated herein.
 - 2. Section 28 46 30 – Network Equipment.

1.2 SYSTEM DESCRIPTION

- A. Provide a closed circuit television (CCTV) system complete with all cameras, cabling, connectors, backboxes, raceway, equipment racks, headend equipment, monitoring equipment, recording equipment, monitors and software to provide a complete and operable system.
- B. CCTV system shall be connected to a dedicated CCTV network backbone, configured for multicast routing. Provide integration to other systems as identified on the drawings and in these specifications.
- C. All software shall be formatted, installed, and programmed in compliance with the Contract Documents and the recommendations of the Manufacturer.
- D. System network shall be configured as set forth in Section 28 46 30 – Network Equipment.

1.3 QUALITY ASSURANCE

- A. Comply with all laws, ordinances, rules, regulations and orders of public authorities having jurisdiction over this part of the work. This includes but is not limited to having all necessary licenses, permits and inspections as required by local, state or federal authorities.
- B. CCTV equipment standards: Electronic Industries Association (EIA) Standards, IEEE.
- C. System Manufacturer:

1. Provide CCTV system analog equipment as the products of one manufacturer to assure compatibility, warrantability, serviceability and continuity of components.
2. Provide CCTV system NVMS equipment as the products of one manufacturer to assure compatibility, warrantability, serviceability and continuity of components.
3. Provide CCTV equipment manufactured by one firm specializing in the manufacture of such equipment as evidenced by not less than ten (10) consecutive years producing equipment of complexity and performance as required herein. Contractor must provide evidence of such experience to Owner upon request.
4. Manufacturer must offer 24 hour on-site service support response time upon request.

D. Manufacturer Warranty and Support:

1. The manufacturer of the CCTV system equipment shall provide a sales engineer for inspection of the system during installation and upon completion of the system installation to guarantee that the system has been installed in accordance with the manufacturers published installation instructions, the final reviewed shop drawings, and this specification. Manufacturer's Sales Engineer shall also provide on-site training and support at no charge for all facilities at owner's request.
2. Manufacturer shall provide on-site technical support at no charge (if requested) to assist authorized distributor and owner as required. On site technical support from the manufacturer at no charge shall be offered as long as CCTV equipment is in service.
3. Manufacturer shall offer 24 hour/365 day technical assistance to all customers via toll-free telephone access with guaranteed response times.
4. Manufacturer shall offer a 3 year warranty on all products except monitors, which shall be 1 year. Warranty for equipment shall begin at the time of equipment installation, and not the ship date of equipment.
5. Manufacturer shall offer immediate Advance Replacements of warranty items at no additional charge.
 - a. Specific manufacturer listed shall be used to designate equipment and features desired by the owner. This does not imply that products with equal or superior features shall not be considered by the owner. Manufacturers of substituted products shall also be considered (see Part 1.02, section C and D listed above). Please note that contractor shall be required to submit alternative product substitution requests in writing to owner of all substituted manufacturers and equipment to be used on the project not less than 10 working days prior to bid date. Substitution request shall include letter from contractor describing substitute products and features, and shall also include product data sheets and information. Contractor will also be required to provide demonstrations and hands-on presentation of substituted equipment at owner's request. The owner shall have final authority to review and approve/deny the inclusion of acceptable alternate manufacturers.

E. Response Times:

1. Camera call-up shall be less than 250 milliseconds (mS) from when the signal is sent by the PLC/Touchscreen system and when the image is displayed on the local monitor.
 2. Image latency shall be less than 350mS.
 3. When primary archival storage fails to the secondary or fail-over directory, transition time shall be less than 500mS.
- F. Contractor Qualifications:
1. The Contractor or Systems Integrator shall be a Certified Dealer of the installed CCTV system.

1.4 SUBMITTALS

- A. Submit product data under provisions of Section 28 00 00 and Division 1.
- B. Submittals for Approval:
1. Product Data: Provide data for each component specified showing electrical characteristics and connection requirements.
 - a. Materials list and backbox schedule (including any unique backboxes).
 - b. Technical Data Sheets on each product, including finishes and dimensions.
 - c. Description of system operation.
 - d. Manufacturer's Data:
 - 1) Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.
 - 2) Maintenance Instructions: Include instructions and maintenance schedules for all equipment.
 - 3) Contractor's Dealer Certification.
 2. Image Tagging: Provide document indicating proposed image tags for all CCTV images. Image tagging shall be modified in accordance with Owner direction. As a minimum, provide the following in the submittal:
 - a. Location on the Contract Document floorplans, including room name and room number;
 - b. Camera ID (if not shown on the Contract Documents, this shall be assigned by the Contractor);
 - c. Camera Type and Resolution;
 - d. Description of direction facing;
 - e. Camera tag;
 - f. Camera label (if different from the tag).
 3. Shop Drawings:
 - a. Indicate electrical characteristics and connection requirements, including layout of completed assemblies, interconnecting cabling, dimensions, weights, and external power requirements.

- 1) Riser diagrams per building showing network switching, cabling, cameras, power supplies, storage devices, monitors, PTZ controllers, and ancillary equipment.
 - 2) Riser diagrams showing building interconnection requirements to the campus CCTV network.
 - 3) Interface requirements to ancillary security electronics systems such as PLC, Touchscreen, Intercom and Paging Systems.
 - 4) Provide network video recorder (NVR) minimum storage calculations to demonstrate two years of storage will be provided for each camera requiring recording (as shown on the drawings).
- b. Provide dimensioned floorplan layout showing each camera location and show extents of field of view and wiring paths.
- 1) Include locations of all headend equipment, viewing/monitoring workstations, and report/investigative workstations.
- c. Rack space requirements for all CCTV equipment. Provide elevation of each rack enclosure.
- C. Submittals for Closeout
1. As-Built Data:
 - a. Update shop drawings to conform to actual installation.
 - b. CCTV schedules to include the following:
 - c. Type of lens.
 - d. Network and MAC addressing of each IP based device.
 2. Operations and Maintenance (O&M) Manuals
 - a. See Division 1, GENERAL REQUIREMENTS - Operating and Maintenance Instructions and Section 28 00 00 for additional requirements.
 - b. Product Data: Provide updated information for all Product Data.
 - c. Provide updated information for all Manufacturers' Data.
 - d. Provide system programming documentation and a copy of the system program on DVD disks in the Software Manual.
 - e. Provide all source codes and licenses for the CCTV system in the Software Manual.
 3. Copies of service contracts, costs, and on site response times shall be provided for owner consideration.

1.5 REGULATORY REQUIREMENTS

- A. Equipment enclosures and racks shall be assembled of UL listed materials.

1.6 EXTRA MATERIALS

- A. Provide maintenance materials under provisions of Section 28 00 00.
- B. Provide two of each type of camera.

PART 2 - PRODUCTS

2.1 GENERAL

- A. IP Based Manufacturers: Avigilon to match existing campus infrastructure.

2.2 IP BASED VANDAL RESISTANT CAMERAS

- A. Color cameras shall be a 1/3-inch CMOS Progressive Scan vandal resistant minidome. The camera shall incorporate day/night technology with mechanical IR cut filter for true day/night performance. Camera shall be rated for 1 lux color and .15 lux night mode.
- B. Camera shall be triple power with 12 VDC, 24 VAC, and Power over Ethernet (POE) capabilities as standard on the camera.
- C. The minidome camera shall include micro SDHC card slot for on-board recording of video when required to be accessible via internal web browser. Audio inputs shall be available on the dome for line-level audio and mic inputs when required.
- D. Video Compression shall be H.264 and MJPEG for second streaming functionality and recording when required.
- E. Camera shall include web browser that shall be accessible via Internet Explorer 7.0 or higher, PDA, and Smart Phone technology.
- F. Camera shall be fully ONVIF compliant and fully certified. Camera shall also be IP66 and UL listed.
- G. Camera shall be vandal rated and include an aluminum rugged housing with polycarbonate dome. Security screws shall be available on the camera. Conduit opening shall be available on the side and rear of the dome housing for easy access and installation. Wall and pendant mounts shall be available for those locations as noted on the plans and drawings.
- H. Cameras shall be as shown on the drawings and shall be as follows:
 - 1. 2 Megapixel Cameras:
 - a. Pixel Resolution shall be available in multiple formats, with a maximum resolution of 1080P. Frame rate shall be 30 FPS at full resolution with no delay or slow down of video caused by movement or motion within the scene of view. Video motion detection shall be on-board the camera and fully integrated with the VMS solution provided to allow motion based alarms or recording when required.
 - b. The camera shall be Avigilon 2.0C-H5A-DO1
 - 2. 4 Megapixel Cameras:
 - a. Pixel Resolution shall be available in multiple formats, with a maximum resolution of 2560x1440. Frame rate shall be 20 FPS at full resolution with no delay or slow down of video caused by movement or motion within the scene of view. Video motion detection shall be on-board the camera and fully integrated with the VMS solution provided to allow motion based alarms or recording when required.
 - b. The camera shall be Avigilon 4.0C-H5A-DO1.

- I. Mounting Brackets: Provide mounting brackets as required for installation.

2.3 IP SYSTEM KEYPAD AND CONTROL PANEL

- A. The IP based control keypad shall be able to control camera stations, monitors, and display settings connected to the video system. It shall include a menu-based LCD display which changes to display the proper functionality for the selected device. Selections shall be made using fiber optic backlit soft keys and the control station keyboard. It shall include ergonomic features such as multicolored, oversized keys and a hand rest. The control station menu system shall include a control screen used to select cameras and monitors, sequence video, start or stop tours or salvos, store and recall presets, acknowledge alarms and perform other CCTV functions. Macros shall be available to allow one-keystroke recall of control system functions (up to 16 keystrokes). Other menu screens shall include diagnostics and screen brightness control, as well as user-defined macros and an on-line help system.
- B. There shall be three general system configurations using the control station. Two configurations shall include control systems (one configuration for multiple control systems, one configuration for a single control system. Two power supplies shall be available with the control station; one for 120 V AC and one for 230 V AC. Maximum power consumption shall not exceed 4.8 W.

2.4 NETWORK VIDEO MANAGEMENT SYSTEM

- A. The Video Management Software (VMS) shall meet the requirements of corrections grade surveillance applications. The software shall be unique and power a line of Network Video Recorders, Encoders/Decoders, IP Cameras and Workstations. The software shall provide a complete and comprehensive application for the operation and maintenance of a video surveillance system. It shall provide full live digital video and audio surveillance over a standard 100/1000Base-T network by the use of a GUI incorporating video display areas, toolbars, control palettes, and interactive site map displaying system components.
- B. The software available as a "software only" package or preloaded in a workstation.
- C. The software shall offer network connectivity to other family components and share all video and control data over the network using standard network protocol. The number of network-connected components shall only be limited by the number of assigned IP addresses.
- D. The software shall provide an open platform that allows integration with ONVIF compliant commercial off-the-shelf (COTS) devices, such as: IP cameras, encoders and IP edge devices, including standard resolution and megapixel cameras, from numerous industry-leading manufacturers. It shall support Unicast or Multicast according to the edge device capability.
- E. There shall be no licensing fees for any servers, virtual matrix terminals, encoders, or IP cameras manufactured by the VMS provider. There shall also be no minimum per site camera quantities associated with any software licensing fees. Any licensing fees for third-party cameras, if required, shall only be charged on a per-camera basis. Manufacturers' that limit licenses based on the number of cameras installed at a site or restrict the integration of third-party cameras shall not be acceptable.

- F. The software shall run on a COTS workstation with a minimum of 2.66 GHZ dual-core processor, 2 GB of RAM and 5 GB of disk space. The software shall run on the Microsoft® Windows® XP Professional 32 or 64-bit; Microsoft Vista 32-bit; Microsoft Windows 7 Professional 32 or 64-bit; and Windows 2003 or 2008 Server operating systems.
- G. The software shall offer features including the simultaneous display, playback, distribution and archive of multiple channels of video and audio. It shall collect multiple channels of analog video and digitize them for the purpose of display, archive and requested distribution across the network. Cameras, microphones and sensors shall be the primary input devices. Each channel of video and audio data shall have the capability of being displayed, played back, distributed and archived simultaneously across several servers and clients across the network. The software shall allow recording (version dependent) and viewing at different frame rates (fps). Each sensor channel shall support a NO or NC device.
- H. A web-based interface shall be provided to access the VMS from any standard web browser enabled device. It shall provide live viewing, playback and PTZ controls.
- I. The software shall allow control of an NVR using a keypad or serial host connected to the serial port. The keypad or serial host shall have the ability to start or stop video, play back video, control PTZ movement and start and stop macros.
- J. The software shall support playback from the main screen without losing live video viewing in the following formats:
- K. Quick playback – by using a right mouse-click, the user will be able to select and launch playback for a specific camera in a pre-defined number of seconds before the live image. The playback window will open adjacent to the live one.
- L. Playback from time – shall allow setting the playback to start from a specific date, time and database on the network. This shall allow playing back the same camera several times.
- M. The software shall offer a full multi-user authorization login application. This application shall offer levels of authorization based on defined sites and functions. In addition, a full setup utility shall be available for the Administrator to configure authorizations. A user shall be able to log in by default, as an Administrator or Guest. Guest authorization shall be configurable for specific system operations. Authorization rights setup shall be performed using the Site Authorization screen. Group rights shall be available to configure by specific site. Rights shall provide authority to perform all system functions. The software shall offer a full multi-user authorization process as follows:
 - 1. User groups shall be created once globally and shall function in all components connected to the network.
 - 2. Users shall be created once globally and shall be given rights to particular groups.
 - 3. Groups shall be authorized and given specific access to each unit, permitting “function-specific” profiles.
 - 4. Users created and authorized for each unit shall be able to log in to any recorder and workstation and automatically have their group rights for that machine follow them.

5. There shall be no virtual limit on the number of groups and users that can be authorized in the software on NVRs.
 6. The number of groups and users authorized on the IP cameras and encoders/decoders will be limited to 20 groups and 100 users.
- N. All users created shall be able to log in to any workstation on the system. A user, given appropriate access, shall be able to remotely configure all components connected to the network.
- O. The software shall provide the ability to save any event that was tagged as an alarm (video motion detection, video loss or input received from the EVM system) to be saved to a separate database, where it cannot be overwritten. The feature shall be named Video Vault.
- P. An Archive Wizard shall be provided that simplifies the process of creating archives and saving video to removable media, such as: CD, DVDs or solid-state drives. An embedded player shall be packaged with each archived video clip for playback on any machine.
- Q. The software shall provide an advanced method for creating and executing extensive software commands. This shall be achieved by the use of macros. Macro configuration shall be defined for recorded cameras and microphones, command duration, recording location (version dependent), local viewing, device ID, picture quality, refresh mode, recording rate (fps) (version dependent), related devices (sensors) and alarm activation.
- R. The network and sites configuration shall allow:
1. Site Authorization: Workstation shall be set up using remote recorder or workstation GUI. Site name and authorization shall be established by User and Group. Permissions shall be assigned for all system functions.
 2. Time synchronization of all components on the network.
 3. All appropriate networking features including each server IP, Subnet and Gateway.
- S. There shall be a Recording Verification System used to identify and log any recording errors encountered during normal system operation. The log shall be manually reviewed for possible video segment errors earmarked with a Recording Site, Device Name, Date/Time, Verified Site, Macro Name and Error Description stamp. There shall be a Central Failure Notification (CFN) System used to identify all possible site errors. The CFN shall be accessible from only the Nucleus unit. The log shall be in a time/date order and be manually reviewed for errors.
- T. There shall be a Site Map feature. It shall allow the installation and configuration of a custom screen map used to identify and access site-installed components (recorders, cameras, microphones, etc.). The ideal map shall be a jpg image format in the size of 980 x 735 pixels. In addition, text boxes and sub-maps shall be added to maps, further defining the layout. The utility shall also provide full installation, configuration and editing of maps. Maps of smaller sizes shall have the ability to be moved anywhere on the screen.
- U. The system shall provide alarm notification via e-mail, text messaging, and workstation text. Macros shall be created to view/listen and record video and audio, PTZ cameras at preset positions, trigger alarms over the network and send email or text message for alarms or on schedule.

- V. Storage Database Utilities shall allow setup and usage of detected hard disks locally. Any networked recorder, workstation or server shall be a candidate to add to the picture database. Once established, any recorder shall use established hard disks for recording data.
- W. Alarm Setup: Recorder alarms shall be established by adding detectors and configuring motion detection on video. The triggering of the recorder's detectors shall be used to send alarms to remote units and generate email or text messages. In addition, detectors shall be able to be edited and deleted.
- X. Authentication: The video from the recorder's cameras shall be enabled to verify the authentication of the video and present an authentication symbol on the displayed video for both live and recorded playback.
- Y. System Software shall be Avigilon ACC 7.

2.5 NETWORK VIDEO RECORDER (NVR) STORAGE

- A. Storage for video shall be provided, and it shall be RAID 6 configured storage.
- B. Cameras will be recorded at 10 frames per second at full resolution during motion, and 1 frame per second when motion is not present. There will be motion in the field of view 40% of the time in any given 24 hour period. Storage requirements shall be calculated based upon these parameters.
- C. Storage shall be two years minimum for all cameras.
- D. Upon specific motion activated or external triggered alarms, camera recording will be increased to 10 frames per second at full camera resolution. These alarm conditions will not be used to calculate storage.
- E. RAID storage shall use a combination of COTS drives that shall include a 3 year warranty for reliability and service functionality.
- F. Hard drives must be hot-swappable, and include the ability to swap hard drives without stopping or interrupting the recording functionality.
- G. Hardware based RAID 6 controllers shall be provided. PERC4 SCSI Host Bus Adapter for each RAID to connect to servers shall be provided.
- H. Software based RAID controllers shall not be acceptable.
- I. One (1) hot spare drive shall be provided with each RAID5 unit.
- J. RAID units shall carry a 3 year warranty minimum.

2.6 CLIENT WORKSTATIONS

- A. Reference Section 28 46 30 Network Equipment.

2.7 MONITORS

- A. Reference Section 28 46 30 Network Equipment.

2.8 ACCESSORIES

- A. Ethernet over Coax Adapters:

1. Rack Mount Adapters: Comnet CLFE'x'Coax, www.comnet.net, where the 'x' represents either an 8 or 16 port adapter.
 2. Single Unit Adapters: Comnet CLFE1Coax.
- B. Power Supply: Provide a power supply with minimum of eight (8) individually fused outputs. Outputs shall match camera voltage.
1. 8 Output AC power supplies shall be Altronix #ALTV248, with a 24VAC/28VAC selectable output. Outputs shall be individually fused.
 2. 16 Output AC power supplies shall be Altronix #ALTV2416, with a 24VAC/28VAC selectable output. Outputs shall be individually fused.
 3. 32 Output AC power supplies shall be Altronix #ALTV2432, with a 24VAC/28VAC selectable output. Outputs shall be individually fused.
- C. Midspan Power Injectors:
1. Input 12/24VDC, 24VAC, 100-240VAC.
 2. Power Rating: PoE+, IEEE 802.3at, 25.5W minimum.
 3. Mounting: Wall or pole, NEMA 4X ,IP 66
 4. Data Rate: 10/100/1000Mbps.
 5. Axis T81 series or approved equal.
- D. Equipment Rack Enclosures
1. Reference Section 28 05 01 - Equipment Enclosures.

2.9 WIRE AND CABLE

- A. General:
1. Manufacturers: West Penn Wire/CDT or equal as manufactured by Belden, or Windy City Wire, except for Cat 6 and Fiber Optic cables.
- B. IP Installations:
1. Cable Runs Less than 275 ft: Cat 6 UTP cable. Reference Section 27 15 00 Structured Cabling System. Cabling shall be the same manufacturer and configuration as provided under this section.
 2. Cable Runs Longer than 275 ft:
 - a. Fiber Optic cable. Reference Section 27 15 00 Structured Cabling System. Cabling shall be the same manufacturer and configuration as provided under this section.
 - b. For Ethernet over Coax Installations:
 - 1) Cable Runs Less than 250 ft: RG-59/U Coaxial Cable: West Penn Wire #815 for interior installations; West Penn Wire #AQC819 for exterior installations.
 - 2) Cable Runs Longer than 250 ft and less than 600 ft: RG-6/U Coaxial Cable: West Penn Wire #806 for interior installations; West Penn Wire #6325 for exterior installations.

- 3) Cable Runs Longer than 600 ft: RG-11/U Coaxial Cable: West Penn Wire #811 for interior installations; West Penn Wire #1130 for exterior installations.
 - 4) Connectors: Crimp-on BNC only.
3. Connectors:
- a. Video: RJ-45.
 - b. 24 V power: screw down on spade lug only.
- C. 24V Power: #16TP or as otherwise noted by manufacturer for voltage drop.
- D. FO to Cat 6 Media Converter: Lascomm: LD3800 series converter

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install all wiring in metallic conduit, minimum size ¾", dedicated for CCTV system wiring only. Wiring shall be installed without splices.
- C. Conduit (if necessary) installed between buildings shall be 2" minimum to accommodate future camera additions.
- D. IP Installations:
 1. Elevator Carriage or Cab: Cat 5/5e/6/6A wiring shall not be installed in the elevator hoistway traveler cable. The contractor shall utilize an Ethernet over Coax solution and provide coax cable for the elevator hoistway traveler cable. Coordinate installation requirements with the Specification Section 14 21 00 – Elevators.
- E. Monitors shall be mounted to eliminate the reflectance of any ambient light on the screen.
- F. The Contractor shall be responsible for confirming and following all state and local electrical code requirements. Any deviation from state or local electrical code requirements shall be repaired at contractor's expense.
- G. All cutting, coring, and patching of walls must be accomplished according to local and state code and must be sealed against weather and moisture. Contractors warranty must cover all cutting, coring and patching.
- H. The new fixed cameras shall be positioned according to drawings and pre-bid walk-through. Once the project begins, each camera location shall be confirmed with a signature from an owner representative before the wall mount or camera housing is secured. Cameras shall be housed in appropriate housings, including corner-mount housings, high security housings, indoor housings, and environmental housings.
- I. Head-end CCTV equipment to be rack mounted with keypad and monitors positioned according to drawings and pre-bid walk through. Once the project begins, each head-end equipment location shall be confirmed with a signature from an owner representative. Equipment and equipment rack to be positioned to allow the most secure, yet convenient access for operation and service.

- J. Contractor to provide 20 ft extra power and video wire and cable at head-end equipment locations for each cable run. All wire and cable shall be neatly dressed and tie wrapped. All wire and cable shall terminate directly into head-end equipment with no splicing or patching.
- K. Installation Requirements - Install CCTV equipment with all power supplies, terminal strips, conduit, plastic wireways, and other equipment as required. Contractor shall be responsible for confirming and following all state and local electrical code requirements. Any deviation from state or local electrical code requirements shall be repaired at contractor's expense. All programming and preliminary testing to be accomplished at the shop. Follow installation procedures and wiring recommendations of equipment manufacturer. Every camera shall individually fused or be equipped with an isolation transformer.
- L. Provide necessary interface to the Touchscreen system for camera call-up, viewing, and recording.

3.2 MODIFICATIONS OF EXISTING SYSTEMS

- A. No outages shall be permitted on existing systems except at the time and during the interval specified by the User Agency and by the Owner's Representative. If not so stated by either the User Agency or the Owner's Representative, the maximum outage interval shall be 8 hours. The Owner will require written approval. Provide a scheduled outage plant containing the following items:
 - 1. Identify areas where existing cameras will not be viewable on the system.
 - 2. Identify area where viewing monitors and workstations will not be able to see camera images.
 - 3. Identify existing interfaces to the Touchscreen/PLC systems that will be inoperative as a result of the outage.
 - 4. Any outage must be scheduled when the interruption causes the least interference with normal schedules and business routines. No extra costs will be paid to the Contractor for such outages which must occur outside of regular weekly working hours. Identify dates and times for outage, and any subsequent outages for testing or modifications.
 - 5. Identify corrective actions to be taken should the new program/program update, or hardware modifications not be functional.
 - 6. Written approval must be requested a minimum of 14 days in advance of the scheduled outage.
- B. Prior to making any modifications to the existing system, the Contractor shall download all components of the existing program and provide a backup copy to the Owner on DVD, and keep a copy on site when the new program is uploaded.
- C. Maintain existing system in service until new system is accepted. Disable system only to make updates to the existing program and to add new modules or replace existing modules.
- D. Where existing ONVIF IP based cameras are migrated to a new system, the Contractor shall determine the existing network addressing of the existing system, and re-address/re-program the cameras for full operation on the new system.

- E. The Contractor shall restore any CCTV component interrupted as a result of this work to proper operation within 4 hours. Note that institutional operations are on a seven day week schedule.

3.3 CAMERA MOUNTING

- A. Prior to field installation, the Contractor shall verify cameras are suitable for mounting within specified enclosures. Adjust camera/enclosure combinations as necessary.
- B. In correctional applications, maximum security housings shall be used in all locations less than 11'0" above finished grade or finished floor.
- C. Field verify all mounting requirements for each camera and housing. Provide all necessary mounting brackets.

3.4 OPERATION

- A. When images are displayed on the monitor, all images shall include a tag indicating location of the camera receiving the image.
- B. When a call is placed at a field intercom station, the respective CCTV camera(s) shall be displayed on the control room monitor(s) until the call-in has been cancelled thru the PLC/Touchscreen system.
- C. Where a duress alarm system is shown, upon activation of a duress alarm, cameras capable of viewing the duress alarm shall be displayed on the local monitor and recording shall be activated on those cameras.
- D. Reference the CCTV schedule for information on which camera is to be displayed on the respective monitor.
- E. Monitor configuration:
 - 1. Provide two (2) monitors at the following locations:
 - a. Staff Station 388.4.
 - b. Monitors shall be configured as follows:
 - 1) Right-most Monitor: Shall be used for camera call-up u. A maximum of four (4) cameras shall be displayed on this screen, only upon input from the PLC/Touchscreen Control System.
 - 2) Left-most Monitor: Shall be user configurable for live viewing of cameras within the system. Monitored shall be user configurable up to 16 cameras in grid format.
 - 3) Field verify configuration with Owner's Representative prior to Substantial Completion.

3.5 TESTING

- A. Test all systems to ensure proper performance.
- B. Testing Requirements -The Contractor shall perform all electrical and mechanical tests recommended by the equipment manufacturer and required in this Section. Allow five day "burn-in" time prior to preliminary testing.

3.6 TRAINING

- A. Training Requirements - Provide four hours of training of operational instruction and two hours of maintenance instruction. Seminars to be "hands on" instruction held at facility.

END OF SECTION

PART 1 - GENERAL

1.1 SCOPE & RELATED DOCUMENTS

- A. The work covered by this section of the specifications includes the furnishing of all labor, equipment, materials, and performance of all operations in connection with the installation of the Fire Alarm System as shown on the drawings and as herein specified.
- B. The complete installation is to conform to the applicable sections of 2013 NFPA-72 Code Requirements and National Electrical Code with particular attention to Article 760.
- C. Additionally, the entire installed system and all integrated system operations shall be within the guidelines of the CBC, California Building Code.
- D. The work covered by this section of the specification is to be coordinated with the related work as specified elsewhere under the project specifications.

1.2 QUALITY ASSURANCE

- A. Each and all items of the Fire Alarm System shall be listed as a product of a SINGLE fire alarm system manufacturer under the appropriate category by Underwriters' Laboratories, Inc. (UL), and shall bear the "U.L." label. All control equipment shall be listed under UL category UOJZ as a single unit. Partial listings, or multiple listings for various major sections of the control, shall not be acceptable.
- B. The equipment and installation supervision furnished under this specification is to be provided by Notifier to meet County Standards.
- C. All control equipment must have transient protection devices to comply with 7th edition October 15, 1992 with revisions through June 11, 1993 UL864 requirements.

1.3 GENERAL

- A. Furnish and install a complete Fire Alarm System as described herein and as shown on the plans; to be wired, connected, and left in first class operating condition. The System shall use supervised multiplex data communications circuits, closed loop initiation circuits with individual zone supervision, individual notification appliance circuit supervision, incoming and standby power supervision. Include manual pull stations, key activated pull stations, automatic fire detectors, flashing strobes, annunciators, all wiring, connections to devices, outlet boxes, junction boxes, and all other necessary material for a complete operating system.
 - 1. All software operation shall be stored in a non-volatile programmable memory within the fire alarm control panel. Loss of primary and secondary power shall not erase the instruction stored in memory.

- B. To accommodate and facilitate job site changes, initiation circuits shall be individually configurable on site to provide either alarm/trouble operation, alarm only, trouble only, current limited alarm, no alarm, normally closed device monitoring, a non-latching circuit or a alarm verification circuit.
- C. To accommodate and facilitate job site changes, indicating appliance circuits shall be individually configurable on site to provide upon activation a temporal code until silenced upon any output circuit.
- D. All peripheral devices shall be the standard product of a single manufacturer and shall display the manufacturer's name on each component.
- E. Equipment submissions must include a minimum of the following:
 - 1. Complete descriptive data indicating UL listing of all system components.
 - 2. Complete sequence of operations of the system.
 - 3. Complete system wiring diagrams for components capable of being connected to the system and interfaces to associated equipment.
 - 4. A copy of all State Fire Marshal listing sheets.
 - 5. Fire alarm battery and voltage drop calculations.
- F. The system wiring shall consist of a communications network to interlink all equipment to the main system controls; and a multi-addressable peripherals network to interlink fire alarm devices to the fire alarm control panel. The system shall use digital, full duplex multiplex communication techniques over all circuits to minimize wiring and to maximize system expansion without the need to make an additional home run to the control panel. Each communication circuit shall have the capacity for the addition of addressable devices for future expansion.
- G. Location of all controls, alarm actuating devices and audible alarm signaling devices shall be as shown on drawings and/or required by local authority having jurisdiction.
- H. The contractor shall prepare detailed fire alarm shop drawings, submit to the local fire department, State Fire Marshal and Board of Corrections and receive approval prior to ordering materials and/or starting work. Provide all engineering, calculations, drawings, equipment catalog cut sheets and CSFM listing sheets for submittals to the authority having jurisdiction as necessary to obtain the appropriate approvals.

1.4 OPERATION

- A. The system alarm operation subsequent to the alarm activation of any manual station, automatic detection device, or sprinkler flow switch is to be as follows:
 - 1. All audible alarm indicating appliances shall sound a continuous fire alarm signal until silenced by the alarm silence switch at the control panel or any remote annunciator.

2. All audible alarm indicating appliances shall sound a uniform code 3 temporal pattern until silenced by the alarm silence switch at the control panel or any remote annunciator. The temporal pattern shall consist of any appropriate sound keyed .5 to 1 second "on", .5 to 1 second "off", .5 to 1b second "on", .5 second "of", 2 to 1 second "on", .5 seconds "off", with timing tolerances of " 25%, repeated for not less than 3 minutes.
 3. All visual alarm indicating appliances Xenon Strobes shall display a continuous pattern until system is reset.
 4. All doors normally held open by door control devices shall release. After a 5 second time delay.
 5. A supervised signal to notify the local fire department or an approved central station is to be activated. To accommodate and facilitate job site changes the type of "city connection circuit" is to be on site configurable to provide a digitized signal.
 6. The control panel shall the ability to provide on/off/auto switch(es). In the automatic mode the mechanical controls shall operate the air handling systems as required. The control panel shall the ability indicate "on" or "off" status of the air handling system via separate and distinct "on" and "off" LED indicators. Ability for Manual controls shall be provided to override the automatic functions. A "positive feedback" input is to be provided to indicate true "on" or "off" status from contact closure of the air handling system. This positive feedback indication is to take precedence in determining true "on" or "off" status.
 7. Upon reset of control panel any designated air handling units shall sequentially start up to reduce electrical demand.
 8. An alarm shall be displayed on an 80 character LCD display. The top line of 40 characters shall be the point label and the second line shall be the device type identifier. The system alarm red LED shall flash on the control panel and any remote annunciator until the alarm has been acknowledged at the control panel or any remote annunciator. Once acknowledged, this same LED shall latch on. A subsequent alarm received from another zone after acknowledged shall flash the system alarm LED on the control panel and remote annunciator. The LCD display shall show the new alarm information.
 9. A pulsing alarm tone shall occur within the control panel and the remote annunciator until acknowledged.
- B. The system operation shall be such that the alarm operation of any alarm initiating device shall not prevent the subsequent alarm operation of any other initiating device due to wiring or power limitations.
- C. Alarm and trouble conditions shall be immediately displayed on the control panel front Alphanumeric display. If more alarms or troubles are in the system the operator may scroll to display new alarms.
- D. The alarm sequence is to be recorded with the time and date of all occurrences on the system printer.
- E. All doors normally held open by door control devices shall release upon AC power failure.

- F. The activation of any system smoke detector shall initiate an Alarm Verification operation whereby the panel will reset the activated detector and wait for a second alarm activation. If, within thirty (30) seconds after resetting, a second alarm is reported from the same or any other smoke detector, the system shall process the alarm as described previously. If no second alarm occurs within one minute the system is to resume normal operation. The Alarm Verification is to operate only on smoke detector alarms. Other activated initiating devices shall be processed immediately. The alarm verification operation is to be California State Fire Marshall (CSFM) listed.
1. The control panel shall have the capability to display the number of times a zone has gone into a verification mode.
- G. The control panel shall have a dedicated supervisory service LED and a dedicated supervisory service acknowledge switch.
1. The activation of any standpipe or sprinkler valve tamper switch shall activate the system supervisory service audible signal and illuminate the LED at the control panel and any remote annunciator. Differentiation between valve tamper activation and opens and/or grounds on fire alarm initiation circuit wiring shall be provided.
 2. Activating the Supervisory Service Acknowledge Switch will silence the supervisory audible signal while maintaining the Supervisory Service LED on indicating the tamper contact is still in the off-normal state.
 3. Restoring the valve to the normal position shall cause the Supervisory Service LED to extinguish thus indicating restoration to normal position.
 4. Restoring the valve to the normal position shall cause the supervisory service audible signal to pulse thus indicating restoration to normal position. Activating the Acknowledge Switch will silence the audible signal and restore the system to normal.
- H. The ability to add a manual evacuation switch shall be provided to operate the systems alarm notification appliances. Other control circuits shall not be activated. However, a fire alarm shall be processed as described previously.
- I. The ability to have activation of an auxiliary bypass switch to override the automatic functions either selectively or throughout the system shall be provided.
- J. Alarm and trouble conditions shall be immediately displayed on the control panel Alphanumeric display. If more alarms or troubles are in the system the operator may scroll to display new alarms.
- K. The system shall have an alarm list key that will allow the operator to display all alarms, troubles, and supervisory service conditions with the time of occurrence.
- L. A voltmeter and ammeter shall be provided to indicate battery voltage and charging current.
- M. All doors normally held open by door control devices shall release upon AC power failure.
- N. The control panel shall be capable of supplying 5 Amps @ 24VDC power output expandable to total power required amperes.

- O. The actuation of the enable walk test program at the control panel shall activate the "Walk Teat" mode of the system which shall cause the following to occur:
 - 1. The city connection circuit shall be disconnected.
 - 2. Control relay functions shall be bypassed.
 - 3. The control panel shall show a trouble condition.
 - 4. The panel shall automatically reset itself after signaling is complete.
 - 5. Any momentary opening of an initiating or indicating appliance circuit wiring shall cause the audible signals to sound for 4 seconds to indicate the trouble condition.

1.5 SUPERVISION

- A. The system shall be expandable to contain up to 128 Class 'B' (Style 'B') independently supervised initiation circuits so that a fault in any one zone shall not affect any other zone. The alarm activation of any initiation circuit shall not prevent the subsequent alarm operation of any other initiation circuit.
- B. There shall be sprinkler supervisory initiation device circuits for connection of all sprinkler valve tamper switches to perform the Supervisory Service Operation. Wiring methods which affect any fire alarm initiation circuits to perform this function shall be deemed unacceptable; i.e.: sprinkler and standpipe tamper switches shall NOT be connected to circuits with fire alarm initiation devices. This independent initiation circuit shall be labeled Supervisory Service and shall differentiate between tamper switch activation and wiring faults.
- C. There shall be up to 128 independently supervised and independently fused notification appliance circuits for alarm horns and flashing alarm strobes. Disarrangement conditions of any circuit shall not affect the operation of other circuits.
- D. All auxiliary manual controls shall be supervised so that all switches must be returned to the normal automatic position to clear system trouble.
- E. Each independently supervised circuit shall include a discrete LCD readout to indicate disarrangement conditions per circuit.
- F. The incoming power to the system shall be supervised so that any power failure must be audibly and visually indicated at the control panel and any remote annunciator. A green power LED shall be displayed continuously while incoming power is present.
- G. The system batteries shall be supervised so that a low battery condition or disconnection of the battery shall be audibly and visually indicated at the control panel and any remote annunciator.
- H. The System Expansion Modules shall be electrically supervised for module placement. Should a module become disconnected from the C.P.U. the system trouble indicator must illuminate and audible trouble signal must sound.
- I. The system shall have provisions for disabling and enabling all circuits individually for maintenance or testing purposes.

PART 2 - PRODUCTS

2.1 FIRE ALARM CONTROL PANEL (FACP)

- A. Provide a Fire Alarm Control Panel. Construction is modular with solid state, microprocessor based electronics. It shall display only those primary controls and displays essential to operation during a fire alarm condition. Although the keypad/keyboard can be used for control (firefighter/emergency) of the entire system, it is only be used for maintenance purposes. Keyboards or keypads are not required to operate the system during fire alarm conditions.

- B. Provide all programming for the fire alarm control panel as necessary. To achieve a fully operational system satisfactory to the authority having jurisdiction.

2.2 PERIPHERAL DEVICES

- A. Horns
 - 1. Alarm horns shall be polarized and shall be operated by 24 VDC. Each horn assembly shall include separate wire leads for in/out wiring for each leg of the associated signal circuit. T-tapping of signal device conductors to signal circuit conductors shall NOT be accepted. Alarm horns shall match existing.
- B. Audible/Visible Alarm Notification Appliance
 - 1. Visual units shall be complete with a tamper resistant, Pyramidal shaped lexan lens with "Fire" lettering visible from a 180 degree field of view. The front panel or bezel which is constructed of UL Listed Noryl, may be inverted so that the lens is below the audible device. Integral Xenon strobe shall provide 8000 peak candle power and be adjustable from 1 to 3 flashes per second. Xenon strobe shall provide 4 wire connection to insure properly supervised in/out system connection. Unit shall be complete with all mounting hardware including backbox. Visual unit shall be CSFM Listed for its intended purpose and ADA approved. Visual devices shall match existing.

2.3 ADDRESSABLE PERIPHERAL DEVICES

- A. General
 - 1. The system control panel, over its two wire multidrop channel, must be capable of communicating with the types of addressable devices specified below. The location of addressable devices will be selected along with conventional devices to optimize the system layout in order to provide the level of protection, zone identification and control as shown on the drawings.
- B. Ionization Detector Heads
 - 1. The ionization type detector shall be a plug-in unit which mounts to a twist-lock base and shall be CSFM Listed.
 - 2. In order to provide stability over wide changes in environmental conditions such as temperature, humidity, and pressure, ionization detectors will be dual chamber: one chamber for sampling and one chamber for reference. They will be sealed against rear air flow entry.
 - 3. There shall be no limit to the number of detectors, stations, or Zone Adapter Modules, which may be activated or "in alarm" simultaneously.
 - 4. The detector shall fit into a base that is common with both the heat detector and photoelectric type detector and shall be compatible with other addressable detectors, addressable manual stations, and addressable Zone Adapter Modules on the same circuit. The detector shall also fit into a non-addressable base that is capable of being monitored by an addressable Zone Adapter Module.

5. If field conditions so require, the smoke detection devices shall be covered with plastic covers after installation to maintain cleanliness. The covers shall be red for quick visual identification for removal at time of occupancy.

C. Photoelectric Detector Head

1. The Photoelectric type detector shall be a plug-in unit which mounts to a twist-lock base, and shall be CSFM Listed.
2. The detectors shall be of the solid state photoelectric type and shall contain no radioactive material. They will use a pulsed infrared LED light source and be sealed against rear air flow entry.
3. The detector shall fit into a base that is common with both the heat detector and ionization type detector and shall be compatible with other addressable detectors, addressable manual stations, and addressable Zone Adapter Modules on the same circuit. The detector shall also fit into a non-addressable base that is capable of being monitored by an addressable Zone Adapter Module.
4. There shall be no limit to the number of detectors or Zone Adaptor Modules which may be activated or "in alarm" simultaneously.

D. Addressable Thermal Detector Head

1. Automatic heat detectors shall be combination rate-or-rise and fixed-temperature type. When the fixed-temperature portion is activated, the units shall be self-restorable and give visual evidence of such operation.

E. Addressable Pull Stations

1. Addressable pull stations will contain electronics that communicate the station's status (alarm, normal) to the control panel over two wires which also provide power to the pull station. The address will be set on each station. The stations will be manufactured from high impact red Lexan. Lettering will be raised and painted white. The station will mechanically latch upon operation and remain so until manually reset by opening with a key common to all system locks. Pull stations will be single action double action and identified for local use by raised white LOCAL lettering.
2. The front of the station is to be hinged to a backplate assembly and must be opened with a key to reset the station. The key shall be common with the control panels. Stations which use allen wrenches or special tools to reset, will not be accepted. The station shall consist of high impact Lexan, red in color.
3. The addressable manual station shall be capable of field programming of its "address" location on an addressable signaling line circuit.
4. There shall be no limit to the number of stations, detectors, or Zone Adaptor Modules, which may be activated or "in alarm" simultaneously.
5. The addressable manual station shall be CSFM listed.
6. All pull stations located in detention areas shall be key activated type.

F. Addressable Photoelectric Duct Detector

1. Duct smoke detectors shall be of the solid state photoelectric type and shall operate on the light scattering photodiode principle. The detectors shall be designed to ignore invisible airborne particles or smoke densities that are below the factory set alarm point. No radioactive materials shall be used. Detector construction shall be of the split type, that is, mounting base with twist-lock detecting head. Contacts between the base and head shall be of the bifurcated type using spring-type, self-wiping contacts. Removal of the detector head shall interrupt the supervisory circuit of the fire alarm detection loop and cause a trouble signal at the control panel. Detector design shall provide full solid state construction and compatibility with other normally open fire alarm detection loop devices, (heat detectors), pull station, etc.). Duct housing couplings shall be slotted to insure proper alignment of the sampling and exhaust tubes. Detector shall have an alarm LED visible through a transparent front cover. Detectors shall obtain their operating power from the supervised current in the fire alarm loop. Installation must comply with NFPA-90A.
2. Remote alarm/power LED indicator & key test switch shall be provided for all duct smoke detectors. Locations shall be field verified prior to installation.

G. Smoke Sensors

1. The smoke sensors shall be of the ionization heat photoelectric type and shall communicate actual chamber values to the system control panel.
2. The smoke sensors and bases shall be listed to UL Standard 268 3rd edition, May 1, 1989 with revisions May 2, 1989 and documented compatible with the control equipment to which they are connected. The sensors shall be listed for both ceiling and wall mount applications.
 - a. Photoelectric Sensor Head
 - 1) The sensor shall be of the solid state photoelectric type and shall contain no radioactive material. They will use a pulsed infrared LED light source and be sealed against rear air flow entry.
 - 2) The Photoelectric type sensor shall be a plug-in unit which mounts to a twist-lock base.
 - 3) The sensor shall fit into a base that is common with both the heat sensor and ionization type sensor and shall be compatible with other addressable detectors, addressable manual stations, and addressable Zone Adaptor Modules on the same circuit.
 - 4) There shall be no limit to the number of sensors, stations or Zone Adaptor Modules which may be activated or "in alarm" simultaneously.

- 5) Each sensor will be capable of sensing up to (7) sensitivity levels ranging between .5% and 3.7%.
 - 6) The photoelectric sensor shall have a fine 30 mesh insect screen.
 - 7) The sensor electronics shall be completely shielded to protect against false alarms from EMI and RFI (Electromagnetic and Radio Frequency Interference).
- b. Ionization Sensor Head
- 1) The ionization type sensor shall be a plug-in unit which mounts to a twist-lock base.
 - 2) In order to provide stability over wide changes in environmental conditions such as temperature, humidity and pressure, ionization sensors will be dual chamber: one chamber for sampling and one chamber for reference. They will be sealed against rear air flow entry.
 - 3) The sensor shall fit into a base that is common with both the heat and photoelectric type sensor and shall be compatible with other addressable detectors, addressable manual stations and addressable Zone Adaptor Modules on the same circuit.
 - 4) There shall be no limit to the number of sensors, stations or Zone Adaptor Modules, which may be activated or "in alarm" simultaneously.
 - 5) Each sensor shall be capable of sensing up to (4) sensitivity levels ranging between .5% and 1.3%.
- c. Thermal (Heat) Sensor Head
- 1) The Thermal type sensor shall be a plug-in unit which mounts to a twist-lock base.
 - 2) The sensor shall be combination rate of rise/fixed temperature sensor U.L. Listed as a rate compensated heat detector.
 - 3) The sensor shall fit into a base that is common with both photoelectric and ionization sensors and shall be compatible with other addressable detectors, addressable manual stations, and addressable Zone Adapter Modules on the same circuit.
 - 4) There shall be no limit to the amount of sensors, stations or Zone Adapter Modules, which may be activated or "in alarm" simultaneously.
 - 5) Each sensor is capable of operating at a selectable rate of rise operation of 15 or 20 degrees Fahrenheit per minute and is self-restorable.
 - 6) Each sensor is capable of fixed temperature operation selectable for either 117 or 135 degrees Fahrenheit, independent of the rate of rise setting.
 - 7) Each sensor can be configured for utility monitoring and capable of sensing temperature between 32 and 158 degrees Fahrenheit.
- d. Photoelectric Duct Detector

- 1) The sensor shall be photoelectric type which obtains its operating power from the supervisory current in the fire alarm detection loop.
- 2) Sensors shall be of the solid state photoelectric type and shall operate on the light scattering, photodiode principle. To minimize nuisance alarms, detectors shall have a minimum 30 mesh insect screen and be designed to ignore invisible particles or smoke densities that are below the factory set point. No radioactive material shall be used.
- 3) Detector construction shall have a mounting base with a twist-lock sensing head. The locking feature must be field removable when not required. Contact between the base and head shall be of the bifurcated type utilizing spring type, selfwiping contacts. Removal of the sensor head shall interrupt the supervisory current of the fire alarm detection loop and cause a trouble signal at the control panel. Detector design shall provide compatibility with other addressable detectors, addressable manual stations and addressable zone adapter modules on the same circuit.
- 4) For maintenance purposes, it shall be possible to clean the duct housing sampling tubes by accessing them through the duct housing front cover.
- 5) Auxiliary DPDT relays and/or remote LED alarm indicators and key operated test stations shall be installed where indicated.
 - a) Activation of relays shall be performed through the system program. Tracking the alarm only condition of the duct sensor is not acceptable.
 - b) Each sensor base shall contain a LED that will flash each time it is scanned by the control panel (once every 4 seconds). When the control panel determines that a sensor is in the alarm or a trouble condition, the control panel shall command the LED on that sensor's base to turn on steady indicating the abnormal condition. Sensor which do not provide a visible indication of an abnormal condition at the sensor location shall not be acceptable.
 - c) Each sensor shall be scanned by the control panel for its type identification to prevent inadvertent substitution of another sensor type. The control panel shall operate with the installed device but shall initiate a "Wrong Device" trouble condition until the proper type is installed or the programmed sensor type is changed.
 - d) The sensor's electronics shall be immune from false alarms caused by EMI and RFI.

H. Addressable Sensor Bases

1. Sensor bases shall be compatible with all models of sensors. Each base is capable of communicating sensor values to the panel if a "wrong device type" trouble condition is present. The panel will continue to monitor for alarms and troubles using the default setting for the wrong device until the proper type is installed or the program is changed.
 2. Each sensor base shall contain a LED that will flash each time it is scanned by the control panel (once every 4 seconds). When the control panel determines that a sensor is in the alarm or a trouble condition, the control panel shall command the LED on that sensor's base to turn on steady indicating the abnormal condition. Sensor which do not provide a visible indication of an abnormal condition at the sensor location shall not be acceptable.
 3. Each sensor base shall contain a magnetically actuated test switch to provide for easy alarm testing at the sensor location.
 - a. Sensor Base
 - 1) The sensor base shall annunciate power-on, alarm and trouble conditions locally at the base.
 - 2) In addition, where shown on plans, the sensor base shall remotely annunciate power-on, alarm and trouble conditions using a remote LED Indicator.
 - b. Sensor Base with Relay
 - 1) Where shown on plans, the sensor base shall include a control relay for programmable operation.
 - 2) The relay shall not take any additional addressable device capacity.
 - 3) The relay shall provide (2) sets of form C contacts rated 3 Amps and powered from the system 24VDC and operate in battery standby mode.
 - 4) Relay shall mount in same electrical box the sensor base is installed on.
- I. Zone Adaptor Module
1. Zone Adaptor Modules shall be used for monitoring of waterflow, valve tamper, HFC125 or equivalent Control Panels, non-addressable detectors, and for control of evacuation indicating appliances and AHU systems.
 - a. An addressable interface module shall be provided for interfacing normally open direct contact devices to an addressable signaling line circuit. The device shall be a Fire-Lite type Zone Adaptor Module (ZAM).
 - b. ZAMs will be capable of mounting in a standard electric outlet box. ZAMs will include cover plates to allow surface or flush mounting. ZAMs will receive their 24VDC power from a separate two wire pair running from an appropriate power supply.
 - 1) For conventional 2-wire smoke detector and/or contact device monitoring with Style B or Style A (NFPA-72A initiating device circuit) wiring supervision.

- 2) This type of addressable device module will provide power to and monitor the status of a zone consisting of conventional 2-wire smoke detectors and/or N/O contact devices as specified elsewhere [and identified in a schedule on the plans]. The supervision of the initiating device circuit wiring will be Style B. These ZAMs will communicate the zone's status (normal, alarm, trouble) to the control panel.
- c. The ZAM shall be supervised and uniquely identified by the control panel. Device identification shall be transmitted to the control panel for processing according to the program instructions. Should the ZAM become non-operational, tampered with, or removed, a discrete trouble signal, unique to the device, shall be transmitted to, and annunciated at, the control panel.
- d. The ZAM shall be capable of being programmed for its "address" location on the addressable device signaling line circuit. The ZAM shall be compatible with addressable manual stations and addressable detectors on the same addressable circuit.
- e. All devices will be supervised for trouble conditions. The system control panel will be capable of indicating the type of trouble condition (open, short, device missing/failed). Should a device fail, it will not hinder the operation of other system devices. Should a problem occur on a particular wire run, it will not affect other wire runs.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Provide and install the system in accordance with the plans and specifications, all applicable codes and the manufacturer's recommendations. All wiring shall be installed in strict compliance with all the provisions of CEC - Article 760 A and C, Power-Limited Fire Protective Signaling Circuits or if required may be reclassified as non-power limited and wired in accordance with CEC-Article 760 A and B. Upon completion, the contractor shall so certify in writing to the owner and general contractor.
 1. All junction boxes shall be sprayed red and labeled "Fire Alarm". Wiring color code shall be maintained throughout the installation.
- B. Installation of equipment and devices that pertain to other work in the contract shall be closely coordinated with the appropriate subcontractors.
- C. The contractor shall clean all dirt and debris from the inside and the outside of the fire alarm equipment after completion of the installation.
- D. The manufacturer's authorized representative shall provide onsite supervision of installation.

3.2 TESTING

- A. The completed fire alarm system shall be fully tested in accordance with NFPA-72 by the contractor in the presence of the owner's representative and the State Fire Marshal. Upon completion of a successful test, the contractor shall so certify in writing to the owner and general contractor.

3.3 WARRANTY

- A. The contractor shall warrant the completed fire alarm system wiring and equipment to be free from inherent mechanical and electrical defects for a period of one (1) year from the date of the completed and certified test or from the date of first beneficial use.

- B. The equipment manufacturer shall make available to the owner a maintenance contract proposal to provide a minimum of two (2) inspections and tests per year in compliance with NFPA-72 guidelines.

-END OF SECTION-

PART 1 - GENERAL

1.1 SUMMARY

- A. Applicable provisions of Division 1 shall govern all work under this Section.
- B. Section Includes:
 - 1. Racks and Enclosures.
 - 2. Central Processing Units.
 - 3. Discrete Input and Output Modules.
 - 4. Remote Input and Output Modules.
- C. Related Sections:
 - 1. The Basic Low Voltage Requirements, Section 28 00 00, are part of this Section, and the contract for this work, and apply to this Section as fully as if repeated herein.
 - 2. Section 28 05 01 – Equipment Enclosures.
 - 3. Section 28 46 23 – Touchscreen Control Systems.

1.2 DESCRIPTION

- A. Provide a complete and operable system of solid state Programmable Logic Controllers (PLC) programmed and configured to perform the security functions described in this specification and on the drawings.
- B. Included in this contractor's work is provision of all PLC modules including at least power supply modules, CPU modules, memory modules, communication modules, I/O transmitter modules, various types of discrete input/output (logic I/O) modules and any other modules necessary for each PLC to perform the functions required throughout this specification.
- C. Provide all programming and documentation for the system. Programming and documentation shall be accomplished using a personal computer and online/offline development software which shall be provided by this contractor and shall become the property of the Owner after completion of the installation. The personal computer shall be able to store the control programs on permanent magnetic media and shall be able to quickly restore the program of any PLC in the system should a memory failure occur. Program code and documentation shall become the property of the Owner upon completion of development and acceptance by the Owner. Deliver three (3) complete sets of program documentation including disk backups to the Owner.
- D. All software shall be formatted, installed, and programmed in compliance with the Contract Documents and the recommendations of the Manufacturer.
- E. Provide and install all PLC equipment mounting racks, enclosures, control panels, fixtures, wiring, load isolation relays, connectors, switches, LED annunciators, tone generators with amplifiers, power supplies, loudspeakers and all other items necessary for a complete and operable system as described herein, and any other related portions of the Division 28 specification.
- F. Submittals for the above named substitute equipment shall conform to the requirements of Section 28 00 00, and shall be submitted together with a list of similar installations completed within the last three years. Each completed

installation shall include the name and phone number of an Owner representative to contact for verification.

- G. As part of the substitution request an analysis of the predicted maximum system response time shall be provided by this contractor. The analysis shall include the expected worst case delay time between activation of any panel control or field input and the required response.
- H. This system includes interfacing and interconnection with other low voltage systems described in this specification. Verify the requirements for these interfaces and provide auxiliary equipment necessary for complete functioning of all systems.
- I. Provision of all conduit, line voltage wiring, low voltage wiring and all connections is included under this section of the work.

1.3 SUBMITTALS

- A. Submit product data under provisions of Section 28 00 00 and Division 1.
- B. Submittals for Approval:
 - 1. Include dimensioned shop drawings and wiring diagrams.
 - 2. Product Data: Provide dimensions, ratings, performance data, lamp data, weights and accessory information for each type.
 - 3. Shop Drawings: Provide shop drawings showing system topology, component interconnect diagrams, and individual I/O diagrams. The following items shall be included:
 - a. To scale mechanical drawings showing physical arrangement and mounting details of each component. Include front and back views.
 - b. Wire numbering and addressing associated with each I/O point. This shall be shown on the drawings at the I/O point.
 - 4. System Calculations:
 - a. Provide system calculation showing total number of system inputs and outputs, and number of inputs and outputs in each rack. Provide calculation indication the number of spare I/O modules to be provided in each PLC rack.
 - b. Provide power supply calculations detailing current draws for each module during system operation.
 - 5. System Response: Provide a detailed analysis showing the maximum system response time.
 - 6. This system includes interfacing and interconnection with other low voltage systems described in this specification. Verify the requirements for these interfaces and provide auxiliary equipment necessary for complete functioning of all systems.
- C. Submittals for Close-Out:
 - 1. See Division 1, GENERAL REQUIREMENTS - Operating and Maintenance Instructions Section 01 78 23, and Section 28 00 00 for additional requirements.
 - 2. Operations and Maintenance Manual:
 - a. Product Data: Provide updated information for all Product Data.

- b. Provide all source codes and licenses for the PLC system.
- 3. As-Built Drawings: Provide updated information for the Shop Drawings.

1.4 REGULATORY REQUIREMENTS

- A. Equipment shall be assembled of UL listed materials.

1.5 SYSTEM TOPOLOGY

- A. System Topology for this campus shall consist of a TCP/IP network linking each building with the Touchscreen Control Systems and PLC campus network so that the Touchscreen Control Panels shall be able to monitor and control all I/O points.

1.6 SYSTEM RESPONSE TIME

- A. Reference Section 28 46 23 Touchscreen Control System for maximum system response times.

1.7 EXTRA MATERIALS

- A. Provide maintenance materials under provisions of Section 01 78 23.
- B. Provide one (1) of each type card cage module used.
- C. Provide one (1) PLC power supply.
- D. Provide one (1) of each type of communication module used.
- E. Provide one (1) of each type of input and output module used.

PART 2 - PRODUCTS

2.1 GENERAL

- A. The catalog numbers used are those of Schneider Electric, and constitute the type and quality of equipment to be furnished. These equipment specifications are based on the Modicon M340 Series Programmable Controller family. Modicon shall be used to match existing campus infrastructure.
- B. Wiring and diagrams shown on drawings are provided for logic description only. Verify and install all wiring from approved shop drawings and installation drawings from manufacturers.
- C. All equipment and components shall be installed in equipment cabinets and enclosures as specified in other sections of this specification.
- D. The delay time between system input at either the control panel and/or a field device and the activation of a field device and/or annunciation on the control panel shall not exceed 0.25 seconds. For group operations such as emergency release and group unlock, the delay time between system input at the control panel and the activation of the last field device of a group shall not exceed ten (10) seconds.

2.2 PLC SYSTEM COMPONENTS

- A. The PLC CPU chassis will be provided and installed in standard enclosed and ventilated 19 inch equipment racks using standard brackets available from the

manufacturer. The electronic equipment and all related terminal blocks, relays, power supplies and other equipment will be fully enclosed and ventilated with lockable access.

- B. Common PLC system specifications:
 - 1. Operating temperature (ambient, free air) 32 to 140 degrees Fahrenheit (inlet air at bottom of rack) without the use of fans, air conditioners or additional means of ventilation.
 - 2. Operating humidity, 5% to 95% (non-condensing)
 - 3. AC power source will be 90 to 132 VAC, 47 to 63 Hz.
- C. The PLC system will be designed so that each control area operates totally independent of one another. Failure or loss of a controller will not hamper the operation of any other controller.
- D. Programmable controller manufacturer must guarantee the availability of replacement/spare parts for a minimum of ten (10) years.
- E. Chassis System: Provide assembly chassis with mounting slots for all modules required for PLC system. Chassis will include latching clamps or hold-down screws to secure modules in slots, dead front cover for covering I/O wiring terminals, and wire routing clips.
 - 1. Provide bus expansion module if more than 8 modules are required or remote I/O module to expand I/O capacity.
 - 2. Provide system power supply in each chassis, as required for final system configuration.
 - 3. Provide 10% spare input and 20% spare output capacity in each rack chassis, with a minimum of two blank card slots per chassis.
- F. PLC CPU system modules will be provided, installed and programmed as required to implement all security functions described. The function of each module will be identified by an attached label visible from the front of the chassis.
 - 1. CPU power supply module will provide:
 - a. Power for all internal PLC circuitry
 - b. Line power "On/Off" switch
 - c. Power "On" indicator (only lights if all internal power supplies are within their proper operating ranges)
 - d. Line power input terminals
 - e. Noise immunity will meet requirement of NEMA ICS 2-230 and ANSI C37.90A
 - f. Maximum supply output - 5 amperes at 5 VDC
 - g. Allowable primary power interruptions with no effect on the system will be 30 milliseconds (minimum).
 - h. The system power supplies will be protected against short circuits.
 - 2. Central Processing Unit (CPU) module will include at least the following features:
 - a. Main processing element shall be a distributed microprocessor architecture. Each communication channel shall be driven by an independent microprocessor. Each communication channel

- shall be accessible even if the logic processing or I/O processors have faulted.
- b. CPU LED status indicators will be constantly illuminated to indicate proper CPU operation. They will flash or shut off to indicate certain fault conditions.
 - 1) Program or Run mode.
 - 2) Fault status of the controller.
 - 3) I/O status.
 - 4) RS-232 activity.
 - 5) Battery status.
 - 6) Force LED.
 - c. Serial Port Connector - 9-pin D-type connector for RS-232 serial link to the programming unit.
 - d. User Memory Backup - will provide Flash memory card backup for each individual PLC. The module mounts in the CPU module and is accessible without removing the CPU from the chassis.
 - 1) Memory type: Flash memory card
 - 2) Battery type: Lithium, capable of retaining a program for at least 2 years without application of primary power
 - 3) Memory size: 128 to 512 megabytes selected to match program requirements. Provide at least 25% spare memory at each CPU.
3. Remote I/O Adapter Control Modules shall be provided at each drop of I/O to connect to the main system bus.
- a. Serial communication rate: 5Mbits/sec
 - b. Remote I/O diagnostic functions shall include at least detection and reporting of:
 - 1) Addition or loss of communication with Remote I/O blocks
 - 2) Network Errors
 - 3) Conflicting Remote block addresses
 - 4) Timeout Conditions
 - 5) Adapter faults
4. Communications Modules:
- a. The Programmable Controller will support communication interface modules for Ethernet/IP, ControllerLink, DeviceNet, RS232 and/or RS485 Protocol.
 - b. Ethernet Modules will have a communication rate of 10/100 megabytes/second and be capable of supporting 64 TCP/IP connections. The Ethernet/IP interface will support standard TP/IP communications and standard Ethernet media (10base2, 10base5, 10baseT, 100baseT, and fiber via media converter). The Ethernet/IP interface will support bridging between Ethernet/IP links.
5. Discrete I/O modules will be selected from the family of such modules available from the same manufacturer as the rest of the PLC equipment.

- a. All I/O modules used will provide electro-optical isolation between the field devices and the PLC system backplane and power supplies.
- b. DC input and output modules will be selected to operate properly with 24 VDC levels.
- c. All inputs and outputs will be switched to ground (sunked).
- d. This contractor is responsible for determining the suitability of any output for driving the load attached to it. Some locks develop a 16 ampere inrush current when first energized.
 - 1) DC driven mechanical isolation relays as shown on system wiring block diagrams will be used for A.C. or heavy D.C. load isolation. See other sections of this specification for relay types to be used.
 - 2) DC Input module: The maximum off-state current per input will be 1.5mA.
 - 3) DC Output modules driving isolation relays: The maximum continuous current per output will be 2A; maximum current output per module will be 8A at 30 degrees C.
 - 4) DC Output modules: The maximum continuous current per output will be 0.5A; maximum current output per module will be 4A at 50 degrees C.
- e. 24 VDC power supplies along with all associated terminal strips, sockets, and wiring will be provided for driving the isolated DC system devices. The 24 VDC supplies will be used to power all dc output loads.
- f. At least 20% spare input points and 20% spare output points will be installed in each equipment room which contains a PLC system CPU. These will be in addition to spare parts required elsewhere in this specification.
- g. This contractor will provide identifying labels for each of the I/O modules to indicate specific usage of the module with respect to the field devices.

2.3 PROGRAMMING AND SOFTWARE

- A. PLC CPU system circuit modules shall be provided, installed and programmed as required to implement all security functions described. The function of each circuit module shall be identified by an attached label visible from the front of the chassis.
- B. The programming format shall be IEC 1131-3 compliant Ladder Diagram (LD), Function Block Diagram (FBD), Sequential Function Chart (SFC), and/or Structured Text (ST) languages.
- C. Program changes after initial start-up and operation of the system shall first be made on a separate personal computer and recorded on permanent magnetic media for future reference. The revised program shall then be transferable to the PLC CPU in less than 1 minute of 'off line' time.
- D. It shall be possible to modify any quantity of ladder logic programming directly in the remote run mode without interruption of the PLC scan or bumps to the I/O.

- E. A means to program a fault recovery routine shall exist. When a major system fault (Controller Fault) occurs in the system, the controller fault recovery routine shall be executed and then the system shall determine if the fault has been eliminated. If the fault is eliminated, program execution resumes. If the fault still exists, the system will shut down.
- F. Upon a loss of power, faults or communication failures with PLC input and output modules or PLC CPUs, all electric locks shall de-energize (fail-secure). Sliding and overhead doors shall remain in their present state.
- G. Provide all programming for the system. Provide the latest version of the system programming software. Program code, documentation, system programming software, and programming software documentation shall become the property of the Owner upon completion of development and acceptance by the Owner. Deliver three (3) complete sets of program and software documentation including DVD disk backups to the Owner.

2.4 RACK AND ENCLOSURES

- A. Provide standard enclosed and ventilated wall mounted panels to house the equipment and all miscellaneous mounting parts, shelves, supports and hardware. Panels shall provide at least 15% unused space. Alternate mounting: Floor mounted equipment racks.
- B. Reference Section 28 05 01 - Equipment Enclosures.

2.5 WIRING

- A. I/O module cable bundles and wiring for connectorized plugs shall be as recommended by the Manufacturer.
- B. Network cabling between remote I/O and the CPU chassis shall be as recommended by the Manufacturer.
- C. Cabling between I/O modules and interposing relays: Reference Section 28 05 13 - Low Voltage Wire and Cable.
- D. Fiber Optic and Category 6 wiring: Reference Sections 27 15 10 Structured Cabling System. Cabling shall be the same manufacturer and configuration as provided under this section.

2.6 OPERATIONAL REQUIREMENTS

- A. Failure of any PLC or PLCs shall not impact the operation of those remaining operational except to the extent that remote indications from the failed PLC may be lost.
- B. Each PLC shall have an integral watch-dog circuit which shall indicate any detectable failure at the associated operator control console.
- C. Unusual and/or normal system perturbations, disruptions or fluctuations shall in no circumstance unlock or otherwise cause any door or lock which was secure prior to the perturbation, disruption or fluctuation to become unsecure as a result of the perturbation, disruption or fluctuation or restoration back to stable steady - state conditions.
- D. All PLC equipment shall meet or exceed the requirements of FCC Rules, Part 15, Subpart J and shall be UL listed.

- E. All PLC outputs shall be configurable for a "failure mode" event. The outputs shall be programmable to either hold their current states or to revert to predetermined default states upon system failure or intentional shutdown.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Locations for PLC equipment racks shall be as shown on the drawings.
- B. Locate CPU and I/O chassis assemblies in the same equipment racks to the greatest extent possible.
 - 1. Backplanes containing interposing door control relays shall be mounted within the same enclosure or equipment rack as the CPU and I/O chassis.
- C. In no case shall I/O chain cable lengths exceed those recommended by the manufacturer for a particular type of I/O chain control module.
 - 1. An I/O transmitter module shall be installed if the cable length to the next downstream I/O station is greater than 50 feet.
 - 2. Maximum cable length between the CPU chassis and all other auxiliary chassis shall be 50 feet or less.
 - 3. Maximum total cable length of the I/O network including all modules connected in series shall not exceed 2000 feet.
- D. Provide power supply isolation between the PLCs and all field devices including LED indicators.
- E. Grounding for this system shall be installed as recommended by the manufacturer. Reference other sections of these specifications for additional grounding requirements.
- F. The "Watchdog" circuit on each PLC shall be connected to LED "maintenance required" indicators at an associated control panel. The connection shall be made such that the indicators light and an alarm tone sounds when the "Watchdog" circuit detects a system failure.
- G. Wiring Installation:
 - 1. Provide all wire, cable, terminal blocks, and fittings.
 - 2. Provide terminal strips or connectorized plugs for connection of all incoming field wiring. Terminate all wiring on terminal blocks for connection to field wiring. Label all terminal strips to coordinate with installation drawings.
 - 3. All wiring shall be bundled and secured to minimize tension on wiring device terminations.
 - 4. All low voltage wiring in consoles shall be Class 1 or Class 2 power limited circuitry in strict accordance with NEC Article 725 except power cords for amplifiers, monitors, etc. Maintain separation of conductors as required.
 - 5. Wiring system shall be Class 1 for both control and indication. Wiring from control panel to equipment cabinet may be Class 2. Maintain separation of conductors per NEC Article 725.
 - 6. Cable Runs Less than 275 ft: Cat 6 UTP cable. Reference Section 27 13 10 Security Electronics Horizontal Infrastructure

7. Cable Runs Longer than 275 ft: FO cable. Reference Section 27 15 10 Security Electronics and Low-Voltage System Backbone Infrastructure.

3.2 PROGRAMMING

- A. This contractor shall provide all programming required for security system operation as shown on the associated drawings describing the Functional System Diagrams, and described elsewhere in these specifications.
- B. The contractor shall program the PLC to Where group release or emergency group release doors are opened simultaneously, the contractor shall program the PLC to stagger door opening. Additionally, where two or more doors with high inrush currents can be opened simultaneously, on the same power circuit, the PLC shall be programmed to stagger door openings.

3.3 MODIFICATIONS OF EXISTING SYSTEMS

- A. No outages shall be permitted on existing systems except at the time and during the interval specified by the User Agency and by the Owner's Representative. If not so stated by either the User Agency or the Owner's Representative, the maximum outage interval shall be 8 hours. The Owner will require written approval. Provide a scheduled outage plan containing the following items:
 1. Identify areas where key control will be required in the scheduled outage plan.
 2. Identify other PLC modules and systems that will be affected by the outage.
 3. Any outage must be scheduled when the interruption causes the least interference with normal schedules and business routines. No extra costs will be paid to the Contractor for such outages which must occur outside of regular weekly working hours. Identify dates and times for outage, and any subsequent outages for testing or modifications.
 4. Identify corrective actions to be taken should the new program/program update or hardware modifications not be functional.
 5. Written approval must be requested a minimum of 14 days in advance of the scheduled outage.
- B. Prior to making any modifications to the existing system, the Contractor shall download all components of the existing program and provide a backup copy to the Owner on DVD, and keep a copy on site when the new program is uploaded.
- C. Maintain existing system in service until new system is accepted. Disable system only to make updates to the existing program and to add new modules or replace existing modules.
- D. The Contractor shall restore any PLC rack interrupted as a result of this work to proper operation within 4 hours. Note that institutional operations are on a seven day week schedule.

3.4 TESTING

- A. Test completed control panels for operability in accordance with other Sections of this Specification.
- B. Verify unaltered storage capability of nonvolatile memories when subjected to magnetic fields experienced under worst case conditions in the actual electrical rooms where the equipment is located.

- C. Verify unhindered operation of the security control electronics during power loss, transfer to emergency back-up generators and re-transfer to normal power. Verify unhindered operation of the security control electronics during main CPU fault or shutdown where a hot-standby CPU is indicated.
- D. Intentionally simulate a controller fault and verify orderly shut-down of functions and indication of maintenance alarms.
- E. Document all test results on forms approved by the Owner.
- F. Refer to additional testing requirements in Section 28 00 00.

3.5 TRAINING

- A. This contractor shall provide at least 8 hours of actual on-site training on the programming and maintenance of the PLC system to the Owner's maintenance personnel. This training shall be in addition to other requirements stated in other sections of this specification. Training shall be conducted at the project site by persons specially schooled by the manufacturer to provide this training.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Applicable provisions of Division 1 shall govern all work under this Section.
- B. Section Includes:
 - 1. Touchscreen Workstations.
 - 2. Touchscreen Monitors.
 - 3. Touchscreen Software.
 - 4. Interface to existing systems.
- C. Related Sections: The General Low Voltage Requirements, Section 28 00 00, are part of this Section, and the contract for this work, and apply to this Section as fully as if repeated herein.

1.2 SYSTEM DESCRIPTION

- A. Provide a complete, fully integrated control and monitoring system for graphical user interface (GUI) where shown on the drawings utilizing a touchscreen system connected to the existing PLC control system. System configuration shall be such that failure of a single component or cable shall not render the system inoperative. Each touchscreen shall be capable of complete individual and simultaneous facility control and monitoring
- B. Provide all labor, materials, equipment, software, and programming, as required for a complete and operational system.
- C. All software shall be formatted, installed, and programmed in compliance with the Contract Documents and the recommendations of the Manufacturer.
- D. Multiplexing of tags shall not be allowed.
- E. All electronic security systems devices shall be controlled, monitored and displayed on a computer based graphical user interface which shall be compatible with the PLC and function in conjunction with all existing electronic security systems to display, control and monitor all devices and functions in the GUI format. Low voltage security electronic systems include:
 - 1. Intercom and Paging Systems.
 - 2. Security door control systems.
 - 3. CCTV Systems.
 - 4. Duress Alarm Systems.
 - 5. Access Control Systems.
 - 6. Personal Duress Alarm Systems.
 - 7. Uninterruptible Power Supply Systems.
 - 8. HVAC Control Systems.
- F. The response time between system input at the touch screen and the activation of field device electric locking hardware shall not exceed 500 milliseconds (0.5mSec); all other field devices shall not exceed 250 milliseconds (0.25mSec). Similarly, the interaction time between field input device and display on the touch screen shall not exceed two hundred fifty milliseconds (0.25mSec). Response will be verified during the in-shop testing prior to delivery of the equipment to the site.

- G. Should a failure occur within the system, the system shall move towards a more secure condition.
- H. Touchscreen System: The specifications herein represent minimum criteria and do not necessarily describe each and every function of a touch screen control system. Complete functions for the touch screen control system will be developed as a joint process between the Owner and the Low Voltage Systems Integrator as part of the submittal process.

1.3 QUALITY ASSURANCE

- A. Contractor Qualifications:
 - 1. The Contractor or Systems Integrator shall be a Certified System Integrator of the installed Touchscreen system.
- B. The software shall be a non-proprietary, OEM SCADA product package available through a distributor network. The software shall be programmed and tailored to the specified functions and features described herein and shown on the drawings. The system software must operate on a Windows (latest supported version) platform. Custom or Proprietary software code will not be accepted.
- C. User Interface software with IO/DA servers other than those listed or branded as the system integrator's as well as any files that included a DLL, EXE or other encrypted file extension will be rejected. Any software approach that is found to be provided with this approach shall be removed. All costs to remove and rewrite the software shall be the Division 28 Contractor's responsibility.

1.4 SUBMITTALS

- A. Submit product data under provisions of Section 28 00 00 and Division 1.
- B. Submittals for Approval:
 - 1. Product Data: Provide data sheets, dimensions, ratings, performance data, and accessory information for each type.
 - a. Provide data sheets for the Touchscreen (GUI) software.
 - 1) Include all necessary additional or optional modules that are required for a fully functional system.
 - b. Provide a statement from the manufacturer indicating the software is the latest version available.
 - c. Provide data sheets indicating workstation and server hardware and software requirements.
 - d. Provide certification from the Manufacturer the Contractor is an approved and Certified System Integrator for the installed GUI software platform.
 - 2. Include dimensioned shop drawings and wiring diagrams.
 - a. Provide shop drawings providing wiring diagrams between Touchscreen system components, including workstations, servers, network equipment, and interface to other systems.
 - b. Provide a system topology and layout showing interrelationship between the server and workstations indicating software installed on each workstation, server, and processing unit.

3. Provide a System Sequence of Operations and Function Guide, showing an overview and general guide of how the Contractor proposes to program the Touchscreen System. This guide shall show all touchscreen functions, including help and utility screens and shall show the graphical representation on the touchscreen and shall also provide a written description of how the system shall operate. The guide shall be in 8.5"x11" format and shall be submitted prior to the Required Meetings indicated in Section 28 00 00 – General Low Voltage Requirements.
 4. Provide all Touchscreen graphical layouts. Include full size drawings detailing each graphic screen proposed.
 - a. Layouts shall be created by the touchscreen configuration software and shall not consist of line drawings created by CAD programs.
 - b. Layouts shall include login screens, floorplan, area plan, and siteplan screens showing device layouts and icon arrangements, menu bars, utility and alarming screens, etc.
 - 1) Once the Owner has reviewed the full size Touchscreen graphical layouts, the Contractor shall schedule a meeting with the Owner, Owner's Representative, and associated Stakeholders to review the layout and operation of the system.
 - 2) The Owner reserves the right to request the Division 28 integrator to make changes to the Touchscreen layouts, including rearrangement of items within each screenshot, changing and/or modifying icons, alarm sounds, and system operations, based on the Owner's policies and procedures, without incurring any additional cost to the Owner.
 5. System Response: Provide a detailed analysis showing the maximum system response time.
 6. This system includes interfacing and interconnection with other low voltage systems described in this specification. Verify the requirements for these interfaces and provide auxiliary equipment necessary for complete functioning of all systems.
- C. Submittals for Verification: Prior to the completion of the project, send final software to the HMI software manufacturer. Provide a letter to the Architect/Engineer from the OEM software provider certifying this software does not include any third party software or compilers, compiled DLL, EXE files or other encrypted files. It is the intention for the owner or owner's representative to be able to edit, maintain or alter this software without the need for any specialized methods other than knowledge of the base HMI and PLC programming language.
- D. Submittals for Close-Out:
1. Operations and Maintenance Manual:
 - a. Product Data: Provide updated information for all Product Data.
 - b. Provide all source codes and licenses for the touchscreen control system.
 2. As-Built Drawings: Provide updated information for the Shop Drawings.

1.5 WARRANTY

- A. The Contractor shall guarantee all wiring and equipment for this system to be free of defects in workmanship and material for a period of one (1) year from the date of acceptance by the Owner.
- B. The Contractor shall provide to the Owner's Representative a preventative maintenance contract with 48-hour guaranteed emergency response service at the time of system acceptance. 48-hour emergency response service shall be applicable during normal contractor working hours. Eight-hour emergency response service shall be provided during after-hour and weekend periods. This contract shall be provided at no additional charge to the Owner for the first year.
- C. The Contractor shall, at the time of bidding, include the cost of a full-coverage preventative maintenance contract similar to the above for the second year as separate line item option.
- D. The Contractor shall, as part of the maintenance contract, guarantee that an adequate stock and supply of replacement parts for the systems shall be maintained at the Contractor's nearest place of business. The Owner may, at the Owner's discretion, elect to maintain additional or supplementary inventories of spare parts.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Environmental ratings for all components of the touchscreen system, except programming equipment, shall meet or exceed the following requirements:
 - 1. Ambient Temperature rating of 0 to 60 C (32 to 140 F) operational and -20 to 70 C (-4 to 158 F) storage.
 - 2. Humidity rating of 10% to 90% Relative Humidity (noncondensing).
 - 3. All system modules shall be designed so as to provide for free airflow convection cooling. No internal fans or other means of cooling except heat sinks, shall be required.

2.2 SYSTEM COMPONENTS

- A. Touchscreen Workstation and Monitors: Reference Section 28 46 30 Network Equipment.
- B. The System shall provide integrated access control and security management functions, according to location of access points, alarm input and output points, time of day, day of week, day of year and personnel.
- C. The System shall allow the incorporation of networked Workstations.
- D. System administration and programming operations shall be available from any Workstation on the System.
- E. The System shall offer TCP/IP-based network communication from the System Server to the primary control panel of each loop utilizing industry standard Ethernet technology as a communications method.

2.3 GRAPHICAL USER INTERFACE SOFTWARE

- A. Manufacturers:
1. Wonderware. Intouch MMI Interface, Irvine, CA
 2. Cimplicity, GE Fanuc, Albany, NY
 3. RSView, Rockwell Automation.
 4. Schneider Vijeo Citect
 5. InduSoft Web Studio
 6. Or approved equal.
 7. The software shall be the latest version of software at the time of shop testing, if later versions are available over that specified.
- B. The Graphical User Interface (GUI) shall meet the following requirements:
1. The GUI/MMI utilized shall be a commercially available development MMI package operating in a Microsoft Windows operating system environment. The software shall be programmed to the specified functions and features described in the contract documents. Provide one (1) complete development package with a site license and a run time license for each station provided.
 2. Have an open architecture that allows the system to run in a multitasking environment with support for on-line dynamic data exchange with other applications such as spreadsheets, and SQL database programs.
 3. Provide internally generated animated graphical objects developed using tool kit provided by original MMI /OEM.
 4. Have display elements such as real time and historical trends, alarm summary displays, bit map images, SPC charts, and shall be configurable with the capability to be placed in any window in any configuration.
 5. Have a graphic drawing system that is object orientated which allows the user the capability to arrange objects.
 6. Be able to configure graphic screens while the system is monitoring the process.
 7. Automatically align and adjust the touch screen display during the boot-up sequence without interaction of the operator.
- C. The GUI software shall include all necessary software modules for a complete and functioning system.
1. Software I/O modules shall allow for the maximum number of I/O tags to be used by the installed system, plus 20% spare. Multiplexing of I/O tags shall not be allowed.
- D. The following screens shall be provided:
1. Log On Screen
 2. Main Screen
 3. Help Screen
 4. Utility Screen
 5. Building Floor Plan Screens
 6. Special Function Screens
- E. Each screen shall have the following common elements:
1. Menu Bar.

2. Time and Date Indication.
 3. A key plan of the building, or part of building, shall be displayed on all screens. Depressing a portion of the key plan shall cause the map of that area to be displayed.
 4. Each map shall be titled and numbered for reference in a consistent location on the screen.
- F. Log On Screen: Provide a Log On icon. Depressing the icon shall allow the alpha-numeric User ID input to the system using a visual representation of a computer keyboard. Successful entry of a User ID and password shall cause the Main Screen to be displayed.
- G. Main Screen: Provide a Main screen that is active when an operator is logged on the touchscreen. The Main screen shall include the following icons:
1. Site Plan Icon
 2. Building Plan Icon
 3. Training Icon
 4. Change User Icon
 5. Log Off Icon
 6. Help Icon
- H. Help and Training Screens: Provide list of help screens and dialogue boxes associated with system for operator selection, detailing each component of the system operation
1. Help Screen: Provide list of help screens and dialogue boxes associated with system for operator selection, detailing each component of the system operation.
 2. Training Screen: Provide a training screen that will log out the operator and place the Touchscreen Control System in 'Training Mode'. While in 'Training Mode', Touchscreen Control System operations will not operate or activate any control functions when logged into the system. The 'Training Mode' will provide simulations for all control functions associated with the Touchscreen Control System.
- I. Utility Screen
1. Control Transfer: display the status of each control location and provide capability for transfer of control.
 2. Camera select screen: display list of all cameras and icons to select any 1 camera to the assigned monitor.
 3. Provide icons to return to Utility Screen or Main Screen on each screen under the Utility Screen.
 4. Network Diagnostics Screen: Provide a screen to view network diagnostics and alarms for the following systems: PLC/Touchscreen Network, CCTV Network, PDAS Network, Intercom and Paging Network, and the Access Control System Network.
- J. Site and Building Floor Plan Screens: Screens shall be developed to display all areas of the facility. Plans shall be scaled to fit the available monitor screen. Screens shall include but not be limited to the following.
1. An overall site plan for selection of a specific area or building on the site.
 2. An overall building plan for selection of individual building.
 3. An overall floor plan of each floor/level of each building of the facility

4. A floor plan of each functional building area such as housing, intake sallyport, medical, etc.
5. If needed, a floor plan of the functional area within a building, i.e. cells, dayrooms, etc.
6. Additional screens may be required to zoom in to selected areas due to scaling factors.
7. Where only a portion of the floorplan is able to be displayed on the screen, include navigation arrow icons to move to adjacent areas.
8. Where there is more than one floor in the building, provide navigation icons to change floor levels.

K. Special Function Screens

1. Screens shall be developed for special functions include emergency life safety functions and security functions.
 - a. Life Safety Screens shall be developed for life safety systems and emergency egress operations. Paths of egress shall be identified on a series of screens.
 - 1) An overall floor plan of each floor/level of each building of the facility
 - 2) A floor plan of each functional building area such as housing, jail support, services, administration, etc.
 - 3) Stairs shall be shaded and a different color to allow recognition of vertical movement when they are a designated egress path.
 - 4) Each screen shall indicate the status of all monitored doors of the area displayed.
 - 5) Egress paths shall be indicated by graphic flowing arrows. Egress paths shall be determined from the Architect's life safety plans.
 2. Security Screens shall be developed for security operations by functional areas, floor, building, etc.
 - 1) An overall floor plan of each floor/level of each building of the facility
 - 2) A floor plan of each functional building area such as housing, jail support, services, administration, etc.
 - 3) Each screen shall indicate the status of all monitored doors of the area displayed
 - 4) Control of electric key function, local control panels, emergency release, etc. by area or group shall be provided on the associated screen.

L. Control Transfer And Control Transfer Screens

1. Screens shall be developed to allow for the following control transfer functions at each station.
 - a. Central Control shall have the ability to take over system operation from any of the dayroom touchscreens at any time.
 - b. Dayroom touchscreens shall have the ability to take over system operation from the adjacent dayroom touchscreen at any time.

- c. Any touchscreen shall have the ability to operate as the central control touchscreen at any time. This function shall have an additional password requirement at the dayroom touchscreen locations in order for any touchscreen that is not physically located in Central Control to operate as the Central Control touchscreen.
 2. All control transfer will provide for the operation of a pre-determined area or areas by a single touchscreen. No simultaneous control of a single area shall be required.
- M. Menu Bar: Provide a menu bar at the bottom of each screen for operation of the touch screen.
 1. Provide an alarm queue indicating a description of the alarm, time received and status of the alarm. Alarms within the queue shall be displayed by priority level, and then for alarms with the same priority level, by the time stamp. An audible alarm shall sound upon system receipt of the alarm. Priority levels shall be as follows:
 - a. Intake sallyports.
 - b. Interior movement doors.
 - c. Cell doors.
 2. Provide a call-in queue indicating description of the call-in device, the time received and the status of the call-in. Call-ins within the queue shall be displayed by priority level. An audible tone shall sound upon system receipt of the call-in. Priority levels shall be as follows:
 - a. Site man-gates.
 - b. Site vehicle gates.
 - c. Vehicle intake sallyports.
 - d. Interior movement doors.
 - e. Cell doors.
 3. Provide a Select icon that when touched will activate the selected activity from the queue, causing movement to the map associated with the selected activity.
 4. Provide a Main icon. The Main icon and text shall be displayed on all screens except the Log On and Main Screen. Touching the Main icon shall cause the Main Screen to be displayed.
 5. Provide a Screen icon with back and forward graphic arrows. The Screen icon shall be displayed on all screens except the Log On.
 6. Provide icons for moving Up and Down between floors when facility includes multiple floors.
- N. Display icons: Control of functions shall be accomplished by the touching of icons on the graphic video display. Touching of an icon shall initiate an audible beep for confirmation.
 1. Each icon shall be separate and distinct for the associated function and consist of symbols and colors.
 2. Icons shall be created so that change in state is indicated by both color and graphical change. Graphic colors and text shall be chosen to meet the goals of the display system and emulate passive presentation systems.
 - a. Secure/Unsecure representation:

- 1) Doors or openings that are unsecure (open) shall be red in color and shall flash.
- 2) Doors or openings that are secure (closed) shall be green in color and shall be solid.
- b. Intercom, Paging, and CCTV system operation:
 - 1) Upon system activation, queue, or call-in, intercom stations, paging speakers and CCTV cameras shall be yellow in color.
 - 2) Upon intercom station call-in, stations shall flash.
- c. Network switches communications:
 - 1) Provide a network map showing all network connections between all communication devices including core and edge switches, touchscreen workstations, servers and ancillary communications equipment. Field devices do not need to be shown.
 - 2) Where a network cable is plugged into the switch, the link or port shall be green in color and shall be solid.
 - 3) Where a switch or network communication device has lost communications, or is in alarm, the switch or communications device shall be red in color and shall flash. Additionally, the link to the upstream device shall also be red and shall flash.
 - 4) Where there is a good connection, the link or port shall be green in color and shall be solid.
 - 5) Where there is a failed connection, the link or port shall be red in color and shall flashing.
 - 6) Where the port is not connected to another core switch or edge device, the color shall be yellow in color and shall be solid.
- d. UPS System Demand:
 - 1) 12-month maximum demand including VA, VAR, W, and power factor.
 - 2) 30-day maximum demand including VA, VAR, W, and power factor.
3. The architectural room numbers shall be placed adjacent to each room name on each screen to facilitate operation. Provide means for toggling on and off the room numbers.
4. Door Control Operations: Provide separate and distinct icons for the following devices:
 - a. Door position indication switch.
 - b. Detention swing or sliding doors.
 - c. Manual swing or sliding doors with electric/pneumatic locking devices and door position indication switches.
 - d. Normal and emergency release operations of movement and cell doors
 - e. Selective group release cell doors.

- f. A door shunt function shall be provided for each door and alarm device. Provide a used configurable time, initially set at 10 minutes in the Utility screen.
 - g. Interlock override functions for each door that is part of one or more interlock groups.
 - h. The Touchscreen Control System shall track each operation of motorized locks, electric locks and electric strikes, whether it is operated from the Touchscreen Control System or from a field device. Include with the System Database the recommended frequency for electric lock and strike maintenance. Upon approaching the recommended frequency for electric lock or strike maintenance (based on Touchscreen Control System or field device operation), the System shall annunciate a message for maintenance and once maintenance has been completed, allow for reset of the schedule.
5. Intercom Control Operations: The status of the intercom shall be indicated by a speaker shaped icon at the intercom location.
- a. Where intercom stations located at movement doors are connected in series, both intercom stations can be represented by a single icon at the movement door.
 - b. Where intercom stations located at movement doors are connected in parallel, each intercom station shall be represented on either side of the movement door by a distinct icon.
6. Auxiliary Control Operations: Provide icons for the control of the following items:
- a. Lighting:
 - 1) Provide on/off lighting control for each dayroom.
 - 2) Provide on/off lighting control for each individual cell. Cell lighting shall only be for the general lighting; night lighting shall be on an un-switched circuit.
 - b. Water Control Valves
7. Duress Alarm Operations: Icons shall not be visible except when in the alarm condition.
- a. For duress alarm systems that provide zone annunciation only, the entire zone shall be outlined red in the alarm condition. For duress alarm systems that provide point annunciation, the alarm shall be annunciated at the point of occurrence.
 - b. For duress alarms associated with CCTV cameras, the associated camera(s) shall be displayed on the appropriate CCTV monitor.
8. Closed Circuit Television System (CCTV):
- a. Icons for cameras shall be located on the graphic in their approximate location or in a location that will support the visual relationship for operation of a remote device (i.e. intercom, door).
 - b. Where the camera is associated with an intercom and/or door, the camera image shall be displayed on the appropriate CCTV monitor upon system call-up, without touching the CCTV icon.
 - c. Touching the icon shall cause the video image to be displayed on the associated monitor.
9. Auxiliary Alarm Annunciation:

- a. Annunciation of UPS alarms shall be provided to indicate inverter malfunction, UPS on line, and low battery.
 - b. Annunciation of PLC system alarms shall be provided for low battery, processor trouble, communications trouble, rack system trouble and power supply trouble. A pre-recorded audio message shall be associated with the alarm at time it is placed in the first line of the activity list.
 - c. Annunciation of security electronics network status:
 - 1) Provide GUI maps showing core switch interconnects, connections to edge device switches, showing link status between devices.
 - 2) Provide GUI maps showing edge device switch port status.
10. All icons shall change color when the device is active, or in alarm, from the inactive, or non-alarmed state.
- O. The existing database server shall be updated with the following requirements:
- 1. All user reports shall be generated and printed based on password accessibility.
 - 2. Door Activity Report. Report shall include door and area identifier, date, time, and operator information.
 - 3. Alarm Report. Report shall include type of alarm, area identifier, date and time.
 - 4. Communications Report. Report shall include status of communications, type of communications failure, date and time communications are lost and re-established.
 - 5. Maintenance Schedule Report.
 - a. Report shall indicate number of operations of door locks and indicate when scheduled maintenance of each individual door lock is to occur.
 - 6. Employee Log Report. Report shall include data and time operator is in control of the system, and shall be linked to the door activity report.
 - 7. Database information for the report generation indicated above shall be available on the system for a minimum of 180 calendar days. After this time, the user shall be prompted to archive the database to back-up media.
- P. Digitized Voice and Tone Annunciation
- 1. The system shall incorporate digitized voice software so that all operator actions, system warnings, system emergencies, and other pertinent information can be announced to the operator.
 - 2. Executing any sound shall not prevent the operator from performing any screen functions.
 - 3. The operator shall be able to choice voice or tone annunciation. Tone annunciation will utilize beeps and chimes.
 - 4. The owner shall approve the voice and tone annunciations during the system design and software review phase.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The Contractor shall provide the development, loading and checking of the software and/or databases for the complete and proper operation of the systems involved. When the Contractor is required to provide software, it shall be of the most current type and revision. Where licensing of the software is required, the license shall be assigned to the Owner. The Contractor shall provide a copy of the software on media to the Owner prior to system acceptance.
- B. The software shall be a non-proprietary, OEM SCADA product available through a distributor network. The software shall be programmed and tailored to the specified functions and features described herein and shown on the drawings. The system software must operate on a Windows (latest supported version) platform. Custom or Proprietary software code will not be accepted.
- C. Provide only non-proprietary software. For software and software vendors to be considered non-proprietary it must have a minimum of five system integrators proficient in the programming, integration and maintenance of the manufactured software. All software logic shall be developed in the environment and not developed in third party software or provided in a compiled DLL, EXE files or other files requiring a 3rd party compiler outside of the SCADA development environment.
- D. User Interface software with IO/DA servers other than those listed or branded as the system integrator's as well as any files that included a DLL, EXE or other encrypted file extension will be rejected. Any software approach that is found to be provided with this approach shall be removed. All costs to remove and rewrite the software shall be the Electronic Security Contractor's responsibility.
- E. Prior to the completion of the project, send final software to the HMI software manufacturer. Provide a letter to the Architect/Engineer from the OEM software provider certifying this software does not include any third party software or compilers, compiled DLL, EXE files or other encrypted files. It is the intention for the owner or owner's representative to be able to edit, maintain or alter this software without the need for any specialized methods other than knowledge of the base HMI and PLC programming language.
- F. Turn over to owner all termination point and interconnection schedules, all programming source codes including Touch Screen software, PLC development software, Camera recording software, Camera viewing software, and applicable licenses required for operations, maintenance and changes. This is to also include the touch screen and security management system runtime licenses.
- G. Prior to performing any programming, the Contractor shall coordinate with the Owner and shall obtain the Owner's specific programming requirements. The Contractor shall advise the Owner in writing, of the scheduled date for commencement of programming. The Contractor shall provide the Owner the opportunity to assist in development of programming details.
- H. Provide software programming instruction to the owners designated representative. Programming instruction shall include a detailed explanation of how to create I/O and memory tags, icon creation, event logging, create and edit scripts, PLC modifications, independent system programming methods (CCTV, audio, card access system, PLC) for all systems on the project.
- I. Provide all wiring, connectors, power supplies, interfaces, modems, and other hardware as necessary to affect an operating system. Alarm point wiring, low-voltage power supply wiring to alarm devices, interconnect wiring between

system components, and all other wiring not otherwise specified shall be minimum 18 AWG shielded twisted-pair or as specified by appropriate equipment manufacturer. Jacket material shall be suitable for plenum rated ceilings. Cable installed in exterior duct banks shall be suitable for direct burial, with an overall foil shield and water- and UV-resistant jacket. The cable shall be filled to prevent the entry of moisture between the conductors.

- J. All programming of the security system and system components necessary to provide a fully operational system shall be included in the scope of this work. All alarm graphics maps shall be programmed and generated by the Contractor to the satisfaction of the owner. CAD files will be supplied to the Contractor if requested.
- K. These specifications and the drawings submitted with the specifications represent an outline of the system that is desired. The compatibility of the equipment described is the responsibility of the contractor submitting the proposal. It has not been intended to list all parts, interfaces, and miscellaneous equipment that may be needed; it is the responsibility of the contractor submitting the proposal to provide the equipment necessary to provide a properly operating system.
- L. Where existing conditions require additional work or coordination with other Contractors, such as existing door hardware, conduit, or door framing, coordinate exact installation with the Owner's Representative prior to proceeding.

3.2 MODIFICATIONS OF EXISTING SYSTEMS

- A. No outages shall be permitted on existing systems except at the time and during the interval specified by the User Agency and by the Owner's Representative. If not so stated by either the User Agency or the Owner's Representative, the maximum outage interval shall be 4 hours. The Owner will require written approval. Provide a scheduled outage plan containing the following items:
 - 1. Identify areas where key control will be required in the scheduled outage plan.
 - 2. Identify other Touchscreen Control Panels and systems that will be affected by the outage.
 - 3. Any outage must be scheduled when the interruption causes the least interference with normal schedules and business routines. No extra costs will be paid to the Contractor for such outages which must occur outside of regular weekly working hours. Identify dates and times for outage, and any subsequent outages for testing or modifications.
 - 4. Identify corrective actions to be taken should the new program/program update not be functional.
 - 5. Written approval must be requested a minimum of 14 days in advance of the scheduled outage.
- B. Prior to making any modifications to the existing system, the Contractor shall download all components of the existing program and provide a backup copy to the Owner on DVD, and keep a copy on site when the new program is uploaded.
- C. Maintain existing system in service until new system is accepted. Disable system only to make updates to the existing program.

- D. The Contractor shall restore any Touchscreen Control Panel interrupted as a result of this work to proper operation within 4 hours. Note that institutional operations are on a seven day week schedule.

3.3 TESTING

- A. Verify unhindered operation of the security control electronics during power loss, transfer to emergency back-up generators and re-transfer to normal power. Verify unhindered operation of the security control electronics during main CPU fault or shutdown where a hot-standby CPU is indicated.
- B. Intentionally simulate a controller fault and verify orderly shut-down of functions and indication of maintenance alarms.
- C. Document all test results on forms approved by the Owner.
- D. Test completed control panels for operability in accordance with other Sections of this Specification.

3.4 TRAINING AND SYSTEM ACCEPTANCE

- A. Complete documentation shall be provided with the system. The documentation shall completely describe all operations, each program, hardware and peripherals. All updates to documentation will be provided at no additional charge, in the same quantities as originally required.
- B. A training session, being a minimum of two (2), eight-hour (8) sessions in length for the system shall be held by the Contractor at the job-site at times mutually agreed upon between the Owner and the Contractor.
- C. The manufacturer's standard catalog cut sheets shall not be acceptable for use as O&M manuals.
- D. Field set-up time, start-up time, and testing time shall not be considered as training time.
- E. The security system shall not be considered accepted until all punch list items have been corrected in all buildings. Beneficial use of part or all of the system shall not be considered as acceptance.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Applicable provisions of Division 1 shall govern all work under this Section.
- B. Section Includes:
 - 1. Touchscreen Workstation.
 - 2. Touchscreen Monitors.
 - 3. Network Switches.
 - 4. Media Converters.
 - 5. IP Addressing
- C. Related Sections:
 - 1. The Basic Low Voltage Requirements, Section 28 00 00, are part of this Section, and the contract for this work, and apply to this Section as fully as if repeated herein.

1.2 SUBMITTALS

- A. Submit product data under provisions of Section 28 00 00 and Division 1.
- B. Include dimensioned shop drawings and wiring diagrams.
- C. Product Data: Provide data sheets, dimensions, ratings, performance data, and accessory information for each type.
- D. Shop drawings: Include full size drawings detailing each graphic screen proposed.
- E. System Response: Provide a detailed analysis showing the maximum system response time.
- F. This system includes interfacing and interconnection with other low voltage systems described in this specification. Verify the requirements for these interfaces and provide auxiliary equipment necessary for complete functioning of all systems.
- G. Submit an IP addressing scheme for all network based low voltage security electronics systems. The IP addressing scheme shall be approved by the Owner's Representative prior to any network programming.
 - 1. The IP addressing scheme shall include each IP device name and/or number, device port type, device IP address, device network address, device MAC address and any necessary network descriptions.
 - 2. The Contractor may need to adjust the IP addressing scheme to accommodate the Owner's IT requirements.

1.3 OPERATION AND MAINTENANCE MANUALS

- A. See Division 1, GENERAL REQUIREMENTS - Operating and Maintenance Instructions and Section 28 00 00 for additional requirements.
- B. Include copies of the shop drawings and product data indicated above.

- C. Provide all source codes and licenses for the Network Equipment.

1.4 WARRANTY

- A. The Contractor shall guarantee all wiring and equipment for this system to be free of defects in workmanship and material for a period of one (1) year from the date of acceptance by the Owner.
- B. The Contractor shall, at the time of bidding, include the cost of a full-coverage preventative maintenance contract similar to the above for the second year as separate line item option.
- C. The Contractor shall, as part of the maintenance contract, guarantee that an adequate stock and supply of replacement parts for the systems shall be maintained at the Contractor's nearest place of business. The Owner may, at the Owner's discretion, elect to maintain additional or supplementary inventories of spare parts.
- D. Touchscreen Warranty: Monitor – 3 years. Backlight lamp life – 50,000 hours.

PART 2 - PRODUCTS

2.1 TOUCHSCREEN WORKSTATION

- A. The System shall require multiple PC Workstations, number as shown on the drawings. The Workstation shall operate in a Microsoft Windows 10 operating environment.
- B. Workstations shall have the following minimum configuration:
 - 1. Form Factor: Small form factor.
 - 2. Processor: 3.5 GHz, 8MB cache.
 - 3. RAM: 8 GB 2300MHz ECC RAM.
 - 4. Video Card: 4 GB, HDMI, VGA HDMI, DVI, and/or DP output.
 - 5. Hard Disk: 2.5" Serial-ATA Solid State Drive: 300 GB available disk space (after all programs are installed)
 - 6. Floppy Disk: N/A
 - 7. DVD-ROM: 48X, with 32X CD-RW
 - 8. Display: As Noted Below
 - 9. Mouse: USB Mouse
 - 10. Keyboard: USB
 - 11. Com Ports: As Needed
 - 12. Printer Ports: As Needed
 - 13. USB Ports: Minimum of 4, USB 3.0
 - 14. Network Card: RJ-45 (10/100/1000MB)
- C. Workstations shall be as manufactured by Dell, HP, or approved equal.
 - 1. Workstations shall be housed in a locked, ventilated enclosure. Reference Section 28 05 01 for additional requirements.

2.2 CCTV WORKSTATION

- A. The System shall require multiple PC Workstations, number as shown on the drawings. The Workstation shall operate in a Microsoft Windows 10 operating environment.

- B. Multiple workstations shall be installed where indicated on the drawings and networked using Microsoft Windows 8 software.
- C. Workstations shall have the following minimum configuration:
 - 1. Form Factor: Mini Tower
 - 2. Processor: Intel Core i7, 4.50 GHz minimum
 - 3. RAM: 8 GB
 - 4. Video Card: 4 GB, 4 ports - HDMI and/or mini DisplayPort, as required.
 - 5. Hard Disk: 2.5" Serial-ATA Solid State Drive; 300 GB available disk space (after all programs are installed)
 - 6. Floppy Disk: N/A
 - 7. DVD-ROM: 48X, with 32X CD-RW
 - 8. Display: As Noted Below
 - 9. Mouse: USB Mouse
 - 10. Keyboard: USB
 - 11. Com Ports: As Needed
 - 12. Printer Ports: As Needed
 - 13. USB Ports: Minimum of 4, USB3.0
 - 14. Network Card: (2) RJ-45 (10/100/1000MB)
- D. Workstations shall have Avigilon ACC Client Software.
- E. Workstations shall be as manufactured by Avigilon, Dell, HP, or approved equal.
 - 1. Workstations shall be housed in a locked, ventilated enclosure. Reference Section 28 05 01 for additional requirements.

2.3 MONITORS

- A. Desktop/Wall Mounted Touchscreen Monitors
 - 1. General:
 - a. Monitors shall be active matrix TFT LCD monitors with touchscreen overlay as indicated below and removable base.
 - 2. 24" Monitors shall have the minimum following characteristics:
 - a. Aspect Ratio: 16:9.
 - b. Native (Optimal) Resolution: 1920x1080.
 - c. Brightness: 225 nits for Intellitouch and 250 nits for LCD panel.
 - d. Response Time: 5msec typical.
 - e. Viewing Angle: 160 degrees horizontal and vertical.
 - f. Contrast Ratio: 1000:1.
 - g. Monitors shall be Elo Touchsystems 2401L, Desktop/Wall-Mount with Intellitouch Surface Wave Technology.
- B. Standard Monitors
 - 1. General:
 - a. CCTV Interface Monitors: Monitors shall be 24" active matrix TFT LCD with removable base.
 - b. Monitors shall have the minimum following characteristics:

- 1) Aspect Ratio: 16:9.
- 2) Native resolution: 1920x1080 @ 60Hz.
- 3) Brightness: 250cd/m2.
- 4) Response Time: 5 msec typical.
- 5) Viewing angle: 160 degrees horizontal and vertical.
- 6) Contrast Ratio: 1000:1.
- 7) Monitors shall be as manufactured by Dell, HP, or ViewSonic,.

C. Monitor desk mounts shall be Ergotron 200 series, 28-097-200 retractable LCD mounting arm.

D. Monitors shall be VESA mount compliant.

2.4 NETWORK SWITCHES

A. Manufacturers: Cisco, HP, Brocade, or approved equal.

B. Network Switch:

C. PoE Network Switch, Cisco 550X Series

1. SG550X-48MP-K9-NA or approved equal.
 - a. 48 auto sensing 10/100/1000 copper ports.
 - b. Up to 4 fiber optic ports, verify connector type with the Owner prior to ordering.
 - c. Maximum PoE Power available: 375W
 - d. PoE+ available on all ports
 - e. Four 10-Gigabit RJ45/SFP combo ports

D. Fiber Optic Switch:

2.5 AUXILIARY DEVICES

A. Multi-Monitor Mounts:

1. Dual Monitor Arm, Two (2) Stacking Monitors: Ergotron 45-248-026 for screens up to 24" Diameter. Include LCD arms and extensions, pole, and grommet mount. Mounts shall be VESA mounting compatible.

B. Industrial Media Converters

1. Serial to Ethernet Converters: Convert RS-232/422/485 to Ethernet TCP/IP.
 - a. 1-Port Connectivity: Fametech (Tysso) eCOV-135. Provide power supply and management software with converter.
 - b. 4-Port Connectivity: Fametech (Tysso) eCOV-435. Provide power supply and management software with converter.
 - c. Approved equal: Exemys.
2. Fiber Optic to Copper Converters: Convert FO Cabling to Ethernet TCP/IP.

- a. Multimode Fiber Optic Cable:
 - 1) 10/100 Mbps, MM Fiber Optic Cable, SC or ST Connectors: As manufactured by Black Box Network Services, #LIC02xA-R2, or approved equal.
 - 2) 1000 Mbps, MM Fiber Optic Cable, SC Connectors: As manufactured by Black Box Network Services, #LGC320A-R2, or approved equal.
 - 3) 1000 Mbps with PoE, MM Fiber Optic Cable, SC Connectors: As manufactured by Black Box Network Services, #LGC5301A, or approved equal.
 - 4) Approved equal: Comnet.
- b. Singlemode Fiber Optic Cable:
 - 1) 10/100 Mbps, SM Fiber Optic Cable, SC or ST Connectors: As manufactured by Black Box Network Services, #LIC02xA-R2, or approved equal.
 - 2) 1000 Mbps, SM Fiber Optic Cable, SC Connectors: As manufactured by Black Box Network Services, #LGC321A-R2, or approved equal
 - 3) 1000 Mbps with PoE, SM Fiber Optic Cable, SC Connectors: As manufactured by Black Box Network Services, #LGC5302A, or approved equal.
 - 4) Approved equal: Comnet.
- c. Small Form-Factor Pluggable (SFP) Fiber Optic Cable:
 - 1) 1000 Mbps, SFP Fiber Optic Cable, LC Connectors: As manufactured by Black Box Network Services, #LGC340A, or approved equal.
 - 2) 1000 Mbps with PoE, SFP Fiber Optic Cable, LC Connectors: As manufactured by Black Box Network Services, #LGC5300, or approved equal.
 - 3) Approved equal: Comnet.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The Contractor shall provide the development, loading and checking of the software and/or databases for the complete and proper operation of the systems involved. When the Contractor is required to provide software, it shall be of the most current type and revision. Where licensing of the software is required, the license shall be assigned to the Owner. The Contractor shall provide a copy of the software on media to the Owner prior to system acceptance.
- B. Provide all wiring, connectors, power supplies, interfaces, modems, and other hardware as necessary to affect an operating system.
- C. All programming of the security system and system components necessary to provide a fully operational system shall be included in the scope of this work. All Alarm graphics maps shall be programmed and generated by the Contractor to the satisfaction of the owner. CAD files will be supplied to the Contractor if requested.

- D. These specifications and the drawings submitted with the specifications represent an outline of the system that is desired. The compatibility of the equipment described is the responsibility of the contractor submitting the proposal. It has not been intended to list all parts, interfaces, and miscellaneous equipment that may be needed; it is the responsibility of the contractor submitting the proposal to provide the equipment necessary to provide a properly operating system.

3.2 NETWORK PROGRAMMING

- A. The Contractor shall coordinate with the Owner to determine if Class A (0.0.0.0 to 127.255.255.255), Class B (128.0.0.0 to 191.255.255.255), or Class C (192.0.0.0 to 223.255.255.255) network addresses shall be utilized for the networked low voltage security electronics systems. Only use the addressing Class as identified by the Owner.
 - 1. For ease of understanding and future maintenance use subnet mask on character boundaries where possible (255.255.255.0).
 - 2. The IP Addressing shall be complete with all node address assignments.

3.3 TESTING

- A. Verify unhindered operation of the security control electronics during power loss, transfer to emergency back-up generators and re-transfer to normal power. Verify unhindered operation of the security control electronics during main CPU fault or shutdown where a hot-standby CPU is indicated.
- B. Intentionally simulate a controller fault and verify orderly shut-down of functions and indication of maintenance alarms.
- C. Document all test results on forms approved by the Owner.
- D. Test completed control panels for operability in accordance with other Sections of this Specification.

3.4 SYSTEM ACCEPTANCE

- A. The security system shall not be considered accepted until all punch list items have been corrected in all buildings. Beneficial use of part or all of the system shall not be considered as acceptance.

END OF SECTION

PART 1 - GENERAL

1.1 SCOPE

- A. Applicable provisions of Division 1 shall govern all work under this Section.
- B. Section Includes:
 - 1. Uninterruptible Power Supply (UPS) including batteries, rectifier, enclosures, overload protections, disconnecting devices.
 - a. Floor Mounted UPS with Maintenance Bypass.
 - b. DIN Rail Mounted UPS.
 - 2. Maintenance Bypass Switch.
 - 3. Remote Emergency Power Off Switch
 - 4. Communications Interface
- C. Related Sections: The basic Electrical Requirements, Section 28 00 00, are part of this Section, and the contract for this work, and apply to this Section as fully as if repeated herein.

1.2 STANDARDS

- A. The UPS and all associated equipment shall be manufactured in accordance with the following applicable standards:
 - 1. IEEE C62.41, Category A & B
 - 2. ASME
 - 3. CSA 22.2, No. 107.1
 - 4. FCC Part 15, Sub Part B, Class A
 - 5. National Electrical Code (NFPA 70)
 - 6. NEMA PE-I
 - 7. OSHA
 - 8. The UPS shall be ETL listed per UL Standard 1778 Uninterruptible Power Supplies, and shall be CSA certified.
- B. The Quality System for the engineering and manufacturing facility shall be certificated to conform to Quality System Standard ISO 9001 for the design and manufacture of power protection systems for computers and other sensitive electronics.

1.3 SUBMITTALS

- A. Submittals for Approval
 - 1. System configuration with single-line diagrams.
 - 2. Functional relationship of equipment including weights, dimensions, and heat dissipation.
 - 3. Descriptions of equipment to be furnished.
 - 4. Size and weight of shipping units to be handled by contractor.
 - 5. Detailed layouts of customer power and control connections.
 - 6. NEC Code calculations confirming the size of each UPS to be provided, plus 25% spare.
 - 7. Detailed installation drawings including all terminal locations.
 - 8. Interconnect wiring diagrams showing conduit wiring with terminal numbers for each wire.
 - 9. Maintenance Bypass Switch: Submit trip curves for the circuit breakers.

10. Submit IBC certification for the floor mounted UPS to include:
 - a. Certificate of Compliance indicating the seismic design of nonstructural components and systems. Information shall include:
 - 1) Certified Seismic Design Levels.
 - 2) Certified Seismic Installation Methods.
 - 3) Typical seismic restraint details showing the number and location of each support and restraint and the exact number, size, and type of anchor. Typical calculations for the above should have been certified by the Registered Professional Structural Engineer of Record.
- B. Submittals for Closeout
 1. Operation and Maintenance Manuals
 - a. See Division 1, GENERAL REQUIREMENTS - Operating and Maintenance Instructions and Section 28 00 00 for additional requirements.
 - b. Include copies of the shop drawings and product data indicated above.
 - c. Provide all source codes and licenses for the UPS system.

1.4 SYSTEM DESCRIPTION

- A. General: The UPS system shall consist of the appropriate number of modules for capacity and/or redundancy. All modules are to be operating simultaneously and sharing the load. In a non-redundant system, all the modules making up the UPS are required to supply the full rated load. If a power or control module should malfunction, the load is to be transferred automatically to the bypass line. If a battery module should malfunction, it is to be isolated from the system resulting in reduced back up time. For redundant operation, the UPS will have one or more modules than what is required to supply the full rated load. The malfunction of one of the modules shall cause that module to be isolated from the system and the remaining module(s) shall continue to carry the load. Replacement of a module shall be capable without disturbance to the connected load.
- B. Modes of Operation: The UPS shall be designed to operate as a true on-line system in the following modes:
 1. Normal - The critical AC load is continuously supplied by the UPS inverter. The input converter derives power from a utility AC source and supplies DC power to the inverter. The battery charger shall maintain a float-charge on the battery.
 2. Back-up - Upon failure of utility AC power the critical AC load is supplied by the inverter, which obtains power from the battery. There shall be no interruption in power to the critical load upon failure or restoration of the utility AC source.
 3. Recharge - Upon restoration of utility AC power, after a utility AC power outage, the input converter shall automatically restart and resume supplying power to the inverter. Also the battery charger shall recharge the battery.
 4. Automatic Restart - Upon restoration of utility AC power, after a utility AC power outage and complete battery discharge, the UPS shall automatically restart and resume supplying power to the critical load.

Also the battery charger shall automatically recharge the battery. This feature shall be enabled from the factory and shall be capable of being disabled by the user. The user shall also be able to program two auto restart delay settings

- a. Battery capacity % level
 - b. Countdown timer
5. Bypass - The bypass shall provide an alternate path for power to the critical load that shall be capable of operating in the following manner:
- a. Automatic - In the event of an internal failure or should the inverter overload capacity be exceeded, the UPS shall perform an automatic transfer of the critical AC load from the inverter to the bypass source.
 - b. Manual - Should the UPS need to be taken out of service for limited maintenance or repair, manual activation of the bypass shall cause an immediate transfer of the critical AC load from the inverter to the bypass source. The input converter, inverter, and battery charging operations shall continue to operate, provided the control enable switch is in the " On " position.

C. Performance Requirements

1. System: Configuration: Select UPS systems shall be configured or upgradeable to power ratings as follows:
2. Isolation: Input to output isolation shall be provided, via the output transformer, regardless of operating mode. (UPS or bypass).
3. Remote Stop: The UPS shall provide provisions for remote stop capability.
4. AC Input to UPS
 - a. Voltage Configuration: As indicated on the UPS schedule on the drawings or in this specification. The operating voltage range shall be variable based upon output loading percentages as follows:
 - 1) Frequency: 40 to 70 Hz.
 - 2) Input Current Distortion: 5% THD maximum at full load.
 - 3) Input Power Factor: 0.98 lagging at 100% rated load.
 - 4) Inrush Current: 150% of full load input current maximum for 3 cycles.
 - 5) Surge Protection: Sustains input surges without damage per criteria listed in IEEE C62.41, Category B.
5. AC Output
 - a. Voltage Configuration: As indicated on the UPS schedule on the drawings or this specification.
 - b. Voltage Regulation: +/- 3% steady state.
 - c. Frequency Regulation: 60 Hz, +/- 0.5%.
 - d. Frequency Slew Rate: 5.0 Hertz per second maximum.
 - e. Bypass Frequency Synchronization Range: +/- 5.0 Hertz.
 - f. Voltage Distortion: 3% total harmonic distortion (THD) maximum into a 100% linear load, 7% THD maximum into a 100% non-linear load with crest factor ratio of 3:1.

- g. Load Power Factor Range: 0.5 lagging to 1.
 - h. Output Power Rating: Rated kVA at: 0.7 lagging power factor.
 - i. Overload Capability: >100% - 110% indefinitely, 111% -150% for 10 seconds, 151% - 200% for 0.25 seconds, the load shall be transferred to bypass when any of the above conditions are exceeded. >201% for min. 2 cycles, then shut down of UPS. Immediate shutdown into a short circuit.
 - j. Voltage Transient Response: +/- 7% maximum for any load step up to and including 100% of the UPS rating.
 - k. Transient Recovery Time: To within 1% of steady state output voltage within 96 milliseconds.
6. Batteries
- a. Internal Battery: The battery shall consist of gas recombination, valve regulated, lead acid cells. Flame retardant batteries shall be provided, which renders the UPS suitable for installation inside a computer room per requirements of UL Standard 1778.
 - b. Reserve Time: (with ambient temperature between 20 and 25 deg C) The UPS shall contain an internal battery system to provide a reserve time of 6 minutes at 100% load with an equal number of power and battery modules fitted. The UPS shall contain provisions to fit additional battery modules internally if space permits. The UPS shall also interface with an external battery cabinet to extend reserve time capabilities.
 - c. Battery Recharge: To prolong battery life, the UPS shall contain temperature-compensated battery charging. When equal number of power modules and battery modules are fitted the battery charger shall be able to recharge the internal batteries to 90% charge in three to five hours at nominal input voltage and nominal ambient temperature.

1.5 REGULATORY REQUIREMENTS

- A. All equipment shall be UL listed and labeled for the intended use.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A minimum of thirty year's experience in the design, manufacture, and testing of solid-state UPS systems is required.
- B. Factory Testing: Before shipment, the manufacturer shall fully and completely test the system to assure compliance with the specification. These tests shall include operational discharge and recharge tests on the internal battery to guarantee rated performance.

1.7 WARRANTY

- A. The UPS manufacturer shall warrant the UPS against defects in materials and workmanship for two (2) years. The warranty shall cover all parts for two (2) years and onsite labor for ninety (90) days.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All of the uninterruptible power supplies provided under this section shall be by the same manufacturer.
- B. Nominal system capacity, input and output voltage, power factor, and runtime shall be as indicated on the UPS Schedule, within these specifications or on the drawings.
- C. Manufacturers: Basis of Design is Eaton Powerware. Alternate manufacturers: APC, Liebert.

2.2 ENVIRONMENTAL CONDITIONS

- A. Ambient Temperature
 - 1. Operating UPS 0 deg C to +40 deg C; battery 20 deg C to 25 deg C for optimum performance.
 - 2. Storage: UPS -20 deg C to +60 deg C; battery -20 deg C to 25 deg C for maximum 6 months.
- B. Relative Humidity
 - 1. Operating: 5 to 95% non-condensing.
 - 2. Storage: 5 to 95% non-condensing.
- C. Audible Noise: Noise generated by the UPS during normal operation shall not exceed 62 dBA measured at 1 meter from the surface of the UPS.
- D. Electrostatic Discharge: The UPS shall be able to withstand a minimum 15 kV without damage and shall not affect the critical load.

2.3 FLOOR MOUNTED UPS

- A. Fabrication
 - 1. All materials and components making up the UPS shall be new, of current manufacture, and shall not have been in prior service except as required during factory testing. The UPS shall be constructed of replaceable subassemblies. All active electronic devices shall be solid-state.
 - 2. Wiring: Wiring practices, materials, and coding shall be in accordance with the requirements of the National Electrical Code (NFPA 70) and other applicable codes and standards.
 - 3. Cabinet: The UPS unit comprised of: power module, battery module, control module, system interconnect module and user interface module housed in a single free-standing enclosure and meets the requirements of IP20. The UPS system shall be designed such that the battery modules may be installed into any module bay in the cabinet and power modules into any module bay in the top half of the cabinet. The UPS cabinet shall be cleaned, primed, and painted with the manufacturer's standard color. Casters and leveling feet shall be provided. UPS cabinet dimensions shall not exceed 20 inches wide, 29 inches deep and 40 inches high (8 Bay Frame) or 20 inches wide, 29 inches deep, and 53 inches high (12 Bay Frame).
 - 4. Cooling: The UPS shall be forced air cooled by internally mounted fans.
- B. Components
 - 1. Input Converter

- a. General: Incoming AC power shall be converted to a regulated DC output by the input converter for supplying DC power to the inverter. The input converter shall provide input power factor and input current distortion correction.
 - b. AC Input Current Limit: The input converter shall be provided with AC input over current protection.
 - c. Input Protection: The UPS shall have built-in protection against undervoltage, overcurrent, and overvoltage conditions including low-energy surges introduced on the primary AC source and the bypass source. The UPS shall sustain input surges without damage per criteria listed in IEEE C62.41, Category A & B. The UPS cabinet shall contain an input breaker sized to supply full 16kVA rated load and to recharge the battery at the same time.
 - d. Battery Recharge: To prolong battery life, the UPS shall contain temperature-compensated battery charging. When an equal number of power modules and battery modules are fitted the battery charger shall be able to recharge the internal batteries to 90% charge in six hours at nominal input voltage and nominal ambient temperature.
 - e. Charger Output Filter: The battery charger shall have an output filter to minimize ripple current into the battery.
2. Inverter
- a. General: The inverter shall convert DC power from the input converter output, or the battery, into precise regulated sine wave AC power for supporting the critical AC load.
 - b. Overload: The inverter shall be capable of supplying current and voltage for overloads exceeding 100% and up to 200% of full load current. A visual indicator and audible alarm shall indicate overload operation. For greater currents or longer time duration, the inverter shall have electronic current-limiting protection to prevent damage to components. The inverter shall be self-protecting against any magnitude of connected output overload. Inverter control logic shall sense and disconnect the inverter from the critical AC load without the requirement to clear protective fuses. The load shall be transferred to bypass when any of the above conditions are exceeded.
 - c. Maximum Load Alarm: The user can set the alarm point to a value less than 100% rating such that the UPS will alarm before an overload condition or loss of redundancy is reached.
 - d. Output Frequency: The output frequency of the inverter shall be controlled by an oscillator. The oscillator shall hold the inverter output frequency to +/- 0.5% for steady state and transient conditions. The inverter shall track the bypass continuously providing the bypass source maintains a frequency within the user selected synchronization range. If the bypass source fails to remain within the selected range, the inverter shall revert to the internal oscillator.
 - e. Output Protection: The UPS inverter shall employ electronic current limiting.
 - f. Battery over Discharge Protection: To prevent battery damage from over discharging, the UPS control logic shall control the

shutdown voltage set point. This point is dependent on the rate of discharge.

3. Display and Controls
 - a. General: The front panel will consist of multiple status LEDs, switches, and a four line by twenty character LCD display for additional alarm/configuration information. All mimic display LEDs shall be green in color and indicate the following:
 - 1) AC Input
 - 2) On Battery
 - 3) Load On/Off
 - 4) On Inverter
 - 5) On Bypass
 - 6) The UPS fault indicator is used with additional indicators and audible alarms to notify the user that a UPS fault condition has occurred. The color of the fault indicator LED shall be amber.
 - 7) Replace Battery Module
 - 8) Replace Power Module
 - 9) Replace Control Module
 - 10) On Bypass
 - 11) Low Battery
 - 12) OverTemp Warning
 - 13) UPS Shutdown
 - 14) If there is a fault condition, the UPS shall attempt to maintain conditioned power to the load, or at minimum transfer to bypass.
 - 15) There shall also be indication on each module should the module fail and need to be replaced.
 - 16) In addition to a visual fault signal, the UPS shall also record fault occurrences in a rolling event log. The event log on the standard unit shall record up to 255 occurrences, with the oldest events discarded first, etc. The user shall have access to the event log through the LCD display. Every alarm and/or event recorded in the event log will contain a time and date stamp.
 - b. Audible Alarms: The volume of all audible alarms shall be at least 65dBA at a distance of one meter (three feet). An audible alarm shall be used in conjunction with the LED/LCD indication to indicate a change in UPS status. The audible alarms shall enunciate for utility line loss, low battery (while on battery), and all other alarm conditions. For all alarm conditions, the user must look at the display to determine the cause of error/alarm. All alarm tones shall be a continual tone until the condition rectifies itself or the alarm is silenced. Once silenced, the audible alarm shall not sound until a new alarm condition is present.
 - c. Alarm Silence Button: In addition to the load on/off switch, the user interface shall include an audible 'Alarm Silence' switch. If the alarm silence switch is pressed for one second, all current

audible alarms shall be disabled. If a new alarm occurs, or a cancelled alarm condition disappears and then re-appears, the audible alarm is re-enabled.

- d. LCD Display: The LCD display shall be used to provide information to the user. The display shall also be used to program ALL information (voltage, frequency, etc.) into the UPS.
4. Automatic Battery Test
 - a. The UPS shall initiate an automatic battery testing sequence periodically, at a programmed day and time of day, selectable by the end user. The user will be able to select the interval of the battery test and will be able to select 1, 2, 3, 4, or 6 week intervals, or can select to disable the automatic battery test.
 - b. Should a failure of the battery occur, the UPS will immediately return to normal mode and fault signals (visual, audible, and remote via serial) shall be communicated. No audible or remote (via serial/contact closures) indication of the battery test shall be communicated during the duration of the automatic battery test.
 - c. The automatic battery test factory default settings shall be enabled at a two week interval and to occur on Wednesdays at 0600hours (based on the twenty four hour clock).
5. Remote Emergency Power Off (REPO)
 - a. The remote emergency power off function (REPO) shall allow the user to disable all UPS outputs in an emergency situation. The REPO, in order to be flexible, shall be able to interface with either normally open (N.O.) or normally closed (N.C.) systems. The REPO shall be activated when a pair of 'SELV' contacts, external to the UPS, are activated. The REPO connection shall be through a simple terminal block type connector.
 - b. The REPO function shall not operate if no system control modules are present in the UPS or if the manual bypass switch is in the bypass position. The user must also supply a means of interfacing with the REPO circuit to allow disconnecting the UPS input feeder breaker to remove all sources of power to the UPS and the connected equipment to comply with local wiring codes/regulations.
 - c. Regardless of the UPS mode of operation when the REPO is activated, the UPS output shall not be re-enabled until the following occurs:
 - 1) REPO contacts are reset (closed if N.C. contacts are used and open if N.O. contacts are used)
 - 2) Input circuit breaker is closed
 - 3) Control enable switch is turned on
 - 4) User interface on/off switch is depressed
6. Bypass
 - a. General: A bypass circuit shall be provided as an integral part of the UPS. The bypass shall have an overload rating of 300% rated full load for 10 cycles and 1000% for sub-cycle fault clearing. The bypass control logic shall contain an automatic transfer control circuit that senses the status of the inverter logic signals, and operating and alarm conditions. This control circuit shall provide a transfer of the load to the bypass source, without

- exceeding the transient limits specified herein, when an overload or malfunction occurs within the UPS.
- b. Automatic Transfers: The transfer control logic shall automatically activate the bypass, transferring the critical AC load to the bypass source, after the transfer logic senses one of the following conditions:
 - 1) Inverter overload capacity exceeded
 - 2) Inverter over temperature
 - 3) UPS fault condition
 - c. For inverter overload conditions, the transfer control logic shall inhibit an automatic transfer of the critical load to the bypass source if one of the following conditions exists:
 - 1) Inverter/Bypass voltage difference exceeding preset limits ($\pm 15\%$ of nominal)
 - 2) Bypass frequency out of preset limits ($\pm 5\%$ of nominal frequency)
 - d. Automatic Retransfer: Retransfer of the critical AC load from the bypass source to the inverter output shall be automatically initiated unless inhibited by manual control. The transfer control logic shall inhibit an automatic retransfer of the critical load to the inverter if one of the following conditions exists:
 - 1) Bypass out-of-synchronization range with inverter output
 - 2) Overload condition exists in excess of inverter full load rating
 - 3) UPS fault condition present
 - e. Manual Transfer
 - 1) In addition to the internal bypass function, the UPS shall have a manual bypass function. The manual bypass function shall be provided via a switch mounted on the bottom-front of the UPS, removal of the lower front bezel shall be required. The actual AC break time between inverter and bypass shall be less than four milliseconds.
 - 2) The manual bypass shall also be a partial 'wrap-around' bypass, and shall be configured to wrap around the rectifier, battery charger, inverter, and battery in the same manner as the automatic bypass. The manual bypass shall not wrap around the EMI filtering, overcurrent protection or isolation transformer. Manual bypass shall be Liebert NMBHW41.
 - 3) The UPS shall initiate an audible alarm upon transfer to manual bypass. The audible alarm shall be capable of being silenced by the user. The alarm shall continue to sound (unless silenced) while in bypass mode. This shall provide a reminder to the user that the load continues to be powered from utility supply alone.
7. Internal Battery: Flame retardant, valve regulated, gas recombination, lead acid batteries shall be used as a stored-energy source for the specified UPS system. The battery shall be housed in separate replaceable modules that slide into any open bay of the UPS cabinet,

and sized to support the inverter at rated load and power factor, in an ambient temperature between 20° and 25° C, for a 30 minutes reserve time. The expected life of the battery shall be 3 to 5 years or a minimum 250 complete discharge cycles. For extended battery reserve time, additional battery modules may be added, if the frame size allows, external battery cabinets shall be also be available as an option.

C. Communications:

1. The UPS shall allow for flexibility in communications. The UPS shall be able to communicate through two communications ports simultaneously; the media of either communications port may change without affecting the operation of the UPS. The use of relay contacts shall not affect the operation of the two communications ports.
2. The UPS shall communicate the following information:
 - a. On Battery
 - b. Low Battery
 - c. UPS Shutdown.
 - d. UPS Load information:
 - 1) Unit 12-month maximum demand including VA, VAR, W, and power factor.
 - 2) Unit 30-day maximum demand including VA, VAR, W, and power factor.
 - e. Communications shall be via relay contact or SNMP card with RJ-45 connectivity.
3. One connector to provide relay contacts shall be fitted on all UPS models as standard (designated comm port 1). Relay contacts shall be rated 48 VDC, 1 A.
4. Serial Communications: The UPS shall be able to communicate via a specific protocol through a communication port.
5. Network Communications: Provide a network communications module capable of communicating over a local area network, 10/100/1000Mbit Ethernet.
6. UPS Status Information: Provide any necessary proprietary software for command and control of the UPS. The software shall be able to retrieve all status information present in the UPS (and available on the display). Retrieval of data shall be through either serial communications or through a network connection. Workstation for the software shall be provided by the Owner.

2.4 DIN RAIL MOUNTED UPS

- A. DIN Rail mounted UPS, Phoenix Contact, #QUINT Series, or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Equipment shall be installed by the contractor in accordance with final submittals and contract documents. Installation shall comply with applicable state and local codes as required by the authority having jurisdiction. Provide manufacturer's instructions and any supplemental instructions required for the UL listing or labeling of the equipment to the Contractor.
- B. Installation of equipment shall include furnishing and installing all interconnecting wiring between all major equipment provided for the on-site power system. The contractor shall also perform interconnecting wiring between equipment sections (where required), under the supervision of the equipment supplier.
- C. Provide manufacturer's instructions for permanently fastening this equipment (where required) and ensure the seismic requirements of the site are incorporated within these instructions.
- D. Equipment shall be initially started and operated by the supplier.
- E. All equipment shall be physically inspected by the supplier for damage. Scratches and other installation damage shall be repaired, by the supplier, prior to final system testing. Equipment shall be thoroughly cleaned to remove all dirt and construction debris prior to final testing of the system.

3.2 INTERFACE TO OTHER SYSTEMS

- A. Reference Section 28 46 19 Programmable Logic Control System and Section 28 46 23 Touchscreen Control System for additional requirements.

3.3 FIELD QUALITY CONTROL

- A. The following inspections and test procedures shall be performed by factory-trained field service personnel during the UPS start-up.
- B. Visual Inspection
 - 1. Inspect equipment for signs of damage.
 - 2. Verify installation per drawings.
 - 3. Inspect cabinets for foreign objects.
 - 4. Verify neutral and ground conductors are properly sized and configured.
 - 5. Inspect electrolyte level in cells (flooded cells only).
 - 6. Inspect all cell cases.
 - 7. Inspect each cell for proper polarity.
 - 8. Verify all printed circuit boards are configured properly.
- C. Mechanical Inspection
 - 1. Check all control wiring connections for tightness.
 - 2. Check all power wiring connections for tightness.
 - 3. Check all terminal screws, nuts, and/or spade lugs for tightness.
- D. Electrical Inspection
 - 1. Check all fuses for continuity.
 - 2. Confirm input and bypass voltage and phase rotation is correct.

3. Verify control transformer connections are correct for voltages being used.
4. Assure connection and voltage of the battery string(s).

3.4 UNIT START-UP

- A. Perform the following start-up procedures.
 1. Energize control power.
 2. Perform control/logic checks and adjust to meet specification.
 3. Verify DC float and equalize voltage levels.
 4. Verify DC voltage clamp and overvoltage shutdown levels.
 5. Verify battery discharge, low battery warning and low battery shutdown levels.
 6. Verify fuse monitor alarms and system shutdown.
 7. Verify inverter voltages and regulation circuits.
 8. Verify inverter/bypass sync circuits and set overlap time.
 9. Perform manual transfers and returns.
 10. Simulate utility outage.
 11. Verify proper recharge.

3.5 TRAINING

- A. The equipment supplier shall provide training for the facility operating personnel covering operation and maintenance of the equipment provided. The training program shall be not less than 2 hours in duration. Training date shall be coordinated with the facility owner.

3.6 PROGRAMMING

- A. Install all proprietary command and control software on an Owner provided workstation. Connect the UPS thru a TCP/IP network to the touchscreen system and provide all necessary equipment, wiring and programming for this connection.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Applicable provisions of Division 1 shall govern all work under this Section.
- B. Section Includes:
 - 1. Digital Intercom System.
 - 2. System Software.
 - 3. System Programming.
 - 4. Intercom Amplifiers.
 - 5. Paging Amplifiers.
 - 6. Intercom Stations.
 - 7. Paging Speakers.
- C. Related Sections: The Basic Low Voltage Requirements, Section 28 00 00, are part of this Section, and the contract for this work, and apply to this Section as fully as if repeated herein.

1.2 SYSTEM DESCRIPTION

- A. Provide a PLC-controlled, facility-wide, digital audio communication system, which is fully integrated with the Touchscreen System. This system shall provide two-way, remote reply intercommunication between touch screen control station(s) and users and remote intercom stations, speakers, and horns. This system shall allow any remote intercom station or ceiling monitoring speaker to be answered by the touch screen control station in primary control of that particular area, or by the touch screen control station(s) in Central Control during a 'take-over' situation.
- B. The audio communication system shall interface with the CCTV system via the PLC System. When an intercom talk path is established, the CCTV system shall automatically call up any CCTV camera(s) on the intercom call-up monitor of the associated touch screen control station when the remote intercom station is in the camera(s) field of view.
- C. The paging system shall have the capability of reaching individual areas of the facility, or the entire facility. Reference security drawings for paging requirements.
- D. All software shall be formatted, installed, and programmed in compliance with the Contract Documents and the recommendations of the Manufacturer.

1.3 PERFORMANCE REQUIREMENTS

- A. System frequency response: 300 to 3,500 Hz.
- B. Intercom station output: 82 dB SPL at 3 feet with 82 dB SPL input at face of transmitting station.
- C. All system equipment to comply with the radiation limits for Class A digital devices of FCC Rules Part 15, Subpart B.

1.4 SUBMITTALS

- A. Submit product data under provisions of Section 28 00 00 and Division 1.

- B. Submittals for Approval:
 - 1. Product Data: Provide data for each component specified showing electrical characteristics and connection requirements.
 - a. Technical Data Sheets on each product, including finishes and dimensions.
 - b. Description of system operation.
 - 2. Manufacturer's Data:
 - a. Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.
 - b. Maintenance Instructions: Include instructions and maintenance schedules for all equipment.
 - c. Contractor's Dealer Certification.
 - 3. Shop Drawings:
 - a. Indicate electrical characteristics and connection requirements, including layout of completed assemblies, interconnecting cabling, dimensions, weights, and external power requirements.
 - b. Provide dimensioned floorplan layout showing each device location and wiring paths.
 - c. Rack space requirements for all intercom and paging equipment. Provide elevation of each rack enclosure.

- C. Submittals for Closeout:
 - 1. See Section 01770 and Section 28 00 00 for additional requirements.
 - 2. Operation and Maintenance Manuals:
 - a. Product Data: Provide updated information for all Product Data.
 - b. Provide updated information for all Manufacturers' Data.
 - c. Provide system programming documentation and a copy of the system program on DVD disks in the Software Manual.
 - d. Provide all source code, passwords, and licenses for the intercom and paging system in the Software Manual.
 - 3. As-Built Drawings:
 - a. Update Shop Drawings to conform to actual installation.
 - b. Include paging speaker tap values on the drawings, or in schedules.
 - c. Network addressing of each IP based device.

1.5 REGULATORY REQUIREMENTS

- A. Equipment enclosures and racks shall be assembled of UL listed materials.
- B. Custom fabricated enclosures shall be constructed in a UL 508 certified facility as indicated in Section 28 00 00.

1.6 EXTRA MATERIALS

- A. Provide maintenance materials under provisions of Section 01 78 23 – Operation and Maintenance Data.
- B. Provide two of each type of speaker used.
- C. Provide two of each type of grille used.
- D. Provide two of each type of security intercom station used.

PART 2 - PRODUCTS

2.1 DIGITAL INTERCOM SYSTEM

- A. General: System design is based on the MicroComm DXL system as manufactured by the Harding Instrument Company, <http://www.harding.ca>.
- B. Digital Communication Controllers (DCC)
 - 1. Digital Communication Controllers to each form an intercom exchange capable of independent local operation. Exchange capacity to be increased by connecting up to four Digital Communication Expanders to each DCC.
 - 2. Multiple DCC's to be networked together via digital audio trunks and Ethernet data networks to form larger systems.
 - 3. Each DCC to include:
 - a. A Process Control Card (PCC).
 - b. A Master Control Card (MCC).
 - c. Two Station Control Cards (SCC's).
 - d. An optional internal PCI card.
 - e. A front panel keypad/display for system setup and maintenance.
 - f. A 110 VAC, 60 Hz power supply for internal functions.
 - 4. Process Control Card:
 - a. Process Control Card to contain system configuration and data, control exchange operations and switching, and provide exchange network ports.
 - b. Process Control Card to include:
 - 1) USB network ports for exchange expansion.
 - 2) Ethernet network ports for system expansion and external control by touch screen computers and graphic control panels.
 - 3) Fiber optic or copper digital audio trunk ports.
 - 4) Two serial ports.
 - 5) An internal modem for transmitting and receiving data over a telephone line.
 - 5. Master Control Cards:
 - a. Include ports for any combination of two intercom or telephone set master stations.
 - b. Include two line level audio inputs with status and control.

- c. Include two line level audio outputs with status and control.
 - d. Convert incoming audio signals to digital format and outgoing signals to analog format.
 - e. Intercom master station audio, press-to-talk and hook switch status transmitted over two single shielded pair cables with wiring supervision to detect open circuit and short circuit faults.
 - f. Telephone set master station functions all transmitted over a single wiring pair.
6. Station Control Cards:
- a. Each provides sixteen half-duplex intercom station ports which can be employed in adjacent pairs for full duplex devices.
 - b. Provide an interface for intercom stations. Units to convert incoming audio signals to digital format and outgoing signals to analog format. Each channel to monitor the status of up to two (2) switches associated with each intercom station.
 - c. Each card interfaces with 16 half-duplex channels. Each channel includes a separate audio power amplifier for non-blocking call operation and sixteen (16) independent software controlled volume settings.
 - d. All station audio, switch, and power functions on 400 Series and 401 Series cards to be transmitted over a single shielded pair cable with supervision to detect open circuit and short circuit faults.
 - e. Audio and switch functions on 300 Series (Generic Intercom) station control cards to be transmitted on separate wiring pairs.
- C. Digital Communication Expanders (DCE's):
- 1. Digital Communication Expanders to provide master station and intercom features similar to the DCC's to facilitate exchange expansion.
 - 2. Each DCE to include:
 - a. A slave Process Control Card (PCC) without exchange control or network functions.
 - b. A Master Control Card (MCC).
 - c. Two Station Control Cards (SCC's).
 - d. A 110 VAC, 60 Hz power supply for internal functions.
- D. Discrete I/O Modules:
- 1. Each Discrete I/O (input/output) module is to interface up to 48 contact closure type input monitor points and 48 solid-state output control points. Outputs are to be current sink type.
 - 2. Inputs are to be supervised for open circuit and short circuit faults in field wiring. With terminating resistors, each supervised input shall monitor two contact points for a total of 96 inputs.
- E. Page Zone Expanders (PZEs)
- 1. Page Zone Expanders to provide 3 page inputs (from an audio amplifier) with each input having 6 selectable relay controlled outputs
 - 2. Each PZE input to include

- a. 1 relay controlled output for each input that can be used to key an audio amplifier.
- F. Touchscreen Intercom Master Stations:
1. Touch screen intercom master stations to consist of audio interface module and desktop loudspeaker/mic module.
 2. Audio interface to consist of:
 - a. Network and power supply interface, audio amplification and processing module, network and operating status LED's.
 - b. External microphone interface with phantom power capability.
 - c. External loudspeaker interface.
 - d. Telephone handset and press-to-talk switch interfaces.
 - e. Headset jack.
 - f. External buzzer contact closure interface.
 - g. Surface wall mount enclosure nominally 9" H x 6.5" W x 1.8" D.
 3. Desktop loudspeaker/mic module to consist of:
 - a. Desktop loudspeaker/mic unit is to include compact, slim line bottom plate with stainless steel face, and rubber shock isolation mounting feet.
 - b. Unit to include 12 inch, black, slim line electret gooseneck microphone, front mounted loudspeaker, front mounted rotary volume control, and front.
 4. Touchscreen Intercom Master Stations shall be Harding TMM-440
- G. Intercom Stations
1. Intercom stations are to be designed for mounting on standard 2-gang outlet boxes. Faceplates to be constructed of 11 gauge brushed stainless. Internal steel offset grille to restrict inserting objects through speaker grille. Stations to be ruggedly constructed and resistant to damage from soil and sprays.
 2. Each intercom station is to incorporate an internal loudspeaker, microphone preamplifier and function multiplexing circuitry. One (*two*) pushbutton(s) is to be provided on each station. Pushbuttons to be software assignable for placement of call requests or control of auxiliary functions.
 3. Pushbuttons to be single piece stainless steel construction and are backstopped to prevent excessive travel. Switch to have positive tactile action with 1 million-operation lifetime.
 4. Loudspeakers to be waterproof mylar cone type.
 5. All intercom station functions to be transmitted over a single shielded pair cable. Stations to be provided with MTA type insulation displacement connector that requires no wire stripping for installation.
 6. Outdoor intercom stations are to be identical in all respects to standard intercom stations except that all metal plates and hardware to be stainless steel, and internal circuitry and components to be conformally coated.
 7. Intercom stations shall be Harding ICM-420.
- H. Accessories:
1. Quick Connect Board shall be Harding QCB-120.

2. Provide necessary manufacturer's system software, and software programming as required to provide the functions indicated in the Contract Documents.

2.2 ANALOG INTERCOM SYSTEM

A. Amplifiers:

1. Power amplifiers: Provide amplifier for interface between control panel device and paging speakers. Amplifier shall accept microphone, speaker, push-to-talk, and carbon handset intercom inputs from control panels.
 - a. Output at less than 5 percent distortion. Frequency response 20 to 20,000 Hz plus/minus 2dB.
 - b. Noise level 75dB below rated output.
 - c. Input 400 microvolt - microphone, 0.3 volt auxiliary.
 - d. Balanced or single-ended 25 volt and 70 volt outputs at a screw terminal strip.
 - e. Output regulation within 2dB from no load to full load.
 - f. Auxiliary voltage of 28 volts DC, 50 ma maximum.
 - g. Unit rated 105-130 volt, 50-60 Hz.
 - h. Size amplifiers for load requirements; minimum size shall be 150W. Do not load amplifiers more than 90% of rated capacity.
 - i. Model: Bogen Gold Series, or equal as manufactured by TOA, Speco, or approved equal.

B. Paging Speakers:

1. Interior:
 - a. Recessed Paging Speakers: 8 inch, seamless cone type 100 degree dispersion. Frequency Response: 60 - 16,000 Hz minimum. Power rating: 15 watt normal, 25 watt peak. Sensitivity: 96 dB. Voice coil: 1 inch diameter. Impedance: 8 ohm. Transformer: Preassembled with speaker, multiple power taps. Model: Atlas-Soundolier C5T72; Dukane 5A607; Rauland USO2L5.
2. Exterior:
 - a. Recessed Exterior Paging Horn: provide horn of weatherproof construction with minimum 160 degree dispersion. Provide integral line transformer with power taps. Frequency response 475-14,000 Hz. Power rating: 15 watts Model: Atlas-Soundolier APF-15; Dukane; Rauland 3707.
 - b. Surface Mounted Exterior Paging Horn: TOA SC-651, or approved equal. The specified horn speaker shall be designed specifically for outdoor applications. The paging horn speaker shall be a double re-entrant design suitable for paging and tone signaling distribution. The speaker component shall be a compression driver with a polyimide diaphragm to prevent deformation from heat and improve low frequency characteristics.

- 1) Rated Input: 50W (Mobil Mount use: 30W)

- 2) Rated Impedance: 16Ω
- 3) Sensitivity: 109dB (1W, 1m)
- 4) Frequency Response: 250 – 6,000Hz
- 5) IP Code: IP65
- 6) Operating Temperature: -20°C to +55°C (-4°F to 131°F)
(must be free from dew condensation)
- 7) Finish: Horn flare: Aluminum, off-white, powder coating;
Reflector horn: ABS resin, off-white; Bracket holder:
Aluminum, gray, powder coating; Bracket: Steel, gray,
powder coating; Rear cover: ABS resin, gray; Screws
and bolts: Stainless steel.

2.3 WIRE AND CABLE

- A. Provide wire and cable for operation described. Provide separate cable for each intercom station.
- B. Intercom Installations:
 1. Intercom with call-in: Minimum 22 GA one shielded pair and a pair. West Penn Wire #357, for interior installations; West Penn Wire #AQC357 for exterior installations, or equal as manufactured by Belden or Windy City Wire.
- C. Call-in only: Minimum 22 GA one pair, West Penn Wire #221, Belden ft 8442, for interior installations. Minimum #18GA one pair, West Penn Wire #AQC224 for exterior installations.
- D. Page only: Minimum 22 GA one shielded pair. West Penn Wire #4291, Belden ft 9462, for interior installations; West Penn Wire #AQC291 for exterior installations.

2.4 ENCLOSURES

- A. Reference Section 28 05 01 – Equipment Enclosures.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install all wiring in metallic conduit, minimum size ¾", dedicated for intercom and paging speaker wiring only.
 1. Wiring shall be installed without splices.
 2. Cable shields shall be left open at the field intercom station.
- C. Install intercom and call-in stations +54" above the finished floor, except at ADA locations, the stations shall be installed +48" above the finished floor.
- D. Adjust all amplifier controls for optimal performance as determined by the Owner's Representative.
- E. Provide all necessary programming for digital intercom systems.

- F. Provide all necessary interfacing to the Touchscreen and PLC control system.

3.2 DIGITAL INTERCOM SYSTEM INSTALLATION

- A. All digital equipment shall be mounted within either wall mounted or floor mounted equipment racks, as shown on the drawings.
- B. Where the digital system is integrated with a touchscreen control system, intercom connection tones shall be muted at field stations for the following locations:
 - 1. Holding cells.
 - 2. Housing cells.
 - 3. Segregation cells.
- C. Field intercom stations located back-to-back at movement doors shall be connected in parallel to the headend equipment, except where indicated on the drawings. Where indicated on the drawings, field intercom stations located back-to-back at movement doors shall be connected in series to the headend equipment.
- D. Paging Systems:
 - 1. Tap values shown adjacent to paging speakers are intended as a preliminary value only. Speaker tap values shall be adjusted to compensate for ambient noise and the intended use of the space. Obtain Owner approval for the paging system levels prior to substantial completion.

3.3 TESTING

- A. Test all systems to ensure proper performance.
- B. Audio levels shall be set to the satisfaction of the Owner's Representative.

END OF SECTION

PART 1 GENERAL

1.01 DESCRIPTION

- A. Related Requirements specified elsewhere:
 - 1. Section 31 10 13 - Demolition/Debris Removal
 - 2. Section 31 09 16 - Existing Underground Structures
 - 3. Section 31 11 00 - Site Clearing and Grubbing

- B. Requirements of General Conditions and Division 1 apply to all work in this Section.

1.02 INFORMATION ON SITE CONDITIONS

- A. Information obtained by the Designer regarding site conditions, subsurface information, and existing facilities, and similar data are shown on the Plans and are from the information made available by the Owner. Exact location and completeness are not guaranteed.

1.03 CONTRACTOR'S RESPONSIBILITIES

- A. The Contractor shall satisfy himself as to the nature and location of the work, the general and local conditions, particularly those bearing upon availability of transportation, disposal, handling and storage of materials, availability of labor, water, electric power, roads, work in sensitive environment and uncertainties of weather, tidal variations, or similar physical conditions at the site, the conformation and conditions of the ground, the character of equipment facilities needed preliminary to and during the prosecution of the work and all other matters which can in any way affect the work or the cost thereof under this contract.

- B. The Contractor further shall satisfy himself as to the character, quality, and quantity of materials to be encountered from inspecting the site, any exploratory work done by the Owner, as well as from information presented by the Plans and Specifications made a part of this contract. Any failure by the Contractor to acquaint himself with all the available information available as part of the Bid Documents or referenced in the Bid Documents will not relieve him from responsibility for properly estimating the difficulty or cost of successfully performing the work.

- D. The Contractor shall note that many of the existing roads and streets are residential in character and that heavy truck and equipment operations may cause roadway damage in excess of normal usage. Damage caused to the streets by Contractor's operations shall be repaired by the Contractor at no additional cost to the Owner.

1.04 ADDITIONAL INFORMATION

- A. Prior to bidding, bidders may make their own subsurface investigations subject to time schedules and arrangements approved in advance by the Owners Representative. Before any subsurface test holes are excavated, obtain permission from the Owner Representative to perform such work.

END OF SECTION

PART 1 GENERAL

1.01 DESCRIPTION

- A. Related requirements specified elsewhere:
 - 1. Section 31 09 13 - Site Conditions
 - 2. See also Plans for location of utilities and underground structures as they are believed to exist.
- B. Requirements of General Conditions and Division 1 apply to all work in this Section.

1.02 CALIFORNIA ADMINISTRATIVE CODE

- A. Section 1540(a)1 of Construction Safety Orders (Title 8) California Administrative Code, Section 1540 states:
 - 1. "Prior to opening an excavation, effort shall be made to determine whether underground installations; i.e., sewer, water, fuel, electric lines, etc., will be encountered and, if so, where such underground installations are located. When the excavation approaches the approximate location of such an installation, the exact location shall be determined by careful probing or hand digging; and, when it is uncovered, adequate protection shall be provided for the existing installation. All known owners of underground facilities in the area concerned shall be advised of proposed work at least 48 hours prior to the start of actual excavation."
- B. The Engineer has determined the location of existing underground structures based on information made available by the Owner. Exact location and completeness are not guaranteed. However, in line with California's Administrative Code, Section 1540, Contractor shall make the effort to determine the exact location of underground installations.

PART 2 PRODUCTION - OWNERS

2.01 UTILITIES AFFECTED

- A. General
 - 1. The Underground Service Alert (USA), (800) 642-2444 or (800) 227-2600, shall be contacted at least 72 hours before any work commences.
- B. Gas and Electric
 - 1. Pacific Power provides electric service. It should be noted that where overhead service to a structure known requiring it does not exist, then underground power service shall be assumed to exist. Pacific Power can be contacted at (866) 870-3419.
- C. Water and Sewer Service
 - 1. The City of Eureka provides domestic water and sanitary sewer facilities in the project area. The City of Eureka can be contacted at (707) 441-4203.
 - 2. The contractor shall provide temporary sanitary facilities for workers throughout the project.
- D. Telephone

1. AT& T maintains fiber optic lines in the project area. AT&T can be contacted at (833) 669-2166
2. Suddenlink maintains fiber optic lines in the project area, and can be contacted at (844) 874-7558

E. Drainage

The City of Eureka has jurisdiction over drainage within the public right-of-way. The City of Eureka can be contacted at (707) 441-4203.

F. Roads and Streets

The City of Eureka has jurisdiction over nearby roads. They may be contacted by phoning (707) 441-4203.. Caltrans has jurisdiction over Highway 101. They may be contacted by phoning (707) 445-6600.

2.02 TEMPORARY FACILITIES

- A. Contractor shall provide temporary facilities as needed to perform the work included in the contract documents.

PART 3 EXECUTION

3.01 LOCATION OF UTILITIES

- A. The Owner has attempted to identify all existing locations that he has knowledge of and has shown these on the Plans.

3.02 CONTRACTOR RESPONSIBILITY

- A. It may be expected that there will be some variation in location of existing utilities from that as shown on the Plans. Actual location can best be determined in the field after pre-marking by the various utilities affected. Contractor is required to contact Underground Services Alert (USA) before beginning any excavations.
- B. The Contractor shall be responsible for determining the location of existing service laterals or appurtenances whenever the presence of such utilities on the site of the construction can be inferred from the presence of other visible facilities, such as building, meter and junction boxes, located on or adjacent to the site.
- C. The Contractor shall promptly notify the Owner in writing in the event that the Contractor discovers utility facilities not identified by the Owner in the Contract Plans or Specifications.
- D. It should be understood that the various utilities are indicated on the Plans to show only the approximate location and must be verified in the field by the Contractor. It may be expected that there will be variation in location from that as shown on the Plans to the actual location. Actual location can best be determined in the field after premarking by the various utilities affected. The various utilities will cooperate with the Contractor to endeavor to familiarize the Contractor with all known underground utilities obstructions, but this will not relieve the Contractor from assuming full responsibility in anticipating and locating their actual location with respect to utilities which the Contractor must locate and identify under the provisions hereof.

3.03 PRIOR INVESTIGATION

- A. Prior to bidding, the bidders may make their own subsurface investigations, talk to the various utilities affected to secure, for his own information, the knowledge of each utility with the precise location of their facilities so that he may take into account in his bid the difference in location from that believed to exist to that which may actually prove to be the precise location.

END OF SECTION

PART 1 GENERAL

1.01 DESCRIPTION

A. Work included:

Demolition and removal of the miscellaneous items shown on the plans, including but not limited to existing vegetation, asphalt concrete, fences, gates, signs, and construction debris.

B. Requirements of General Conditions and Division 1 apply to all work in this Section.

1.02 QUALITY ASSURANCE

A. In addition to complying with all pertinent codes and regulations, comply with the requirements of those insurance carriers providing coverage for this work.

1.03 JOB CONDITIONS

A. Disposition of material:

1. Title to materials:

- a. Title to all materials to be removed, except as specified otherwise, is vested in the Contractor upon receipt of notice to proceed. The Owner will not be responsible for the condition or loss of, or damage to, such property after notice to proceed.

2. Reuse of materials and equipment:

- a. Carefully remove and store materials and equipment indicated to be reused or relocated to prevent damage, and reinstall as the work progresses.

B. Cleanup:

1. Debris and rubbish:

- a. Contain, remove and transport debris and rubbish in a manner that will prevent spillage to adjacent areas.

2. General:

- a. Use all means necessary to protect existing structures designated to remain and, in the event of damage, immediately make all repairs and replacements necessary to the approval of the Engineer at no additional cost to the Owner.

PART 2 PRODUCTS

Not Applicable

PART 3 EXECUTION

3.01 SITE INSPECTION

- A. Prior to any clearing, grubbing and debris removal work, carefully inspect the site and determine the extent of work involved.
- B. Report any discrepancy to the Owners Representative immediately.

3.02 COORDINATION AND SCHEDULING

- A. Coordinate work with other trades and subcontractors.

3.03 SAFETY

- A. All work shall conform to pertinent OSHA regulations and to other State and local codes and ordinances as applicable.

3.04 PROTECTION

- A. Locate, identify, and protect conduits and other underground utilities indicated to remain, from damage as shown on the Plans.
- B. Protect trees, plant growth, and features designated to remain, as final landscaping.
- C. Protect benchmarks and existing structures from damage or displacement.

3.05 REMOVAL OF DEBRIS

- A. Remove all debris from the site and leave the site in a neat and orderly condition.

END OF SECTION

PART 1 GENERAL

1.01 DESCRIPTION

A. Work included:

Work covered in this section consists of removing all objectionable material from the location of the proposed work. Clearing shall normally be performed in advance of other construction operations in accordance with requirements of these Specifications.

B. Related work described elsewhere:

1. Existing Underground Structures: Section 31 09 16
2. Earth Moving: Section 31 20 00

C. Requirements of General Conditions and Division 1 apply to all work in this Section.

1.02 QUALITY ASSURANCE

A. Qualifications of workmen:

Provide sufficient skilled workmen and supervisors who shall be present at all times during execution of this portion of the work and shall be thoroughly familiar with the type of construction involved and the materials and techniques specified.

1.03 PRESERVATION OF PROPERTY

A. Where construction is to be performed in the vicinity of trees and shrubbery, the work shall be carried on in a manner which will cause minimum damage. Trees which are to be removed will be designated on the drawings. Under no circumstances are additional trees to be removed without written permission from the Owners Representative. Trees and shrubbery that are not to be removed shall be protected from injury or damage resulting from the Contractor's operations. It shall be the responsibility of the Contractor to alert his men, his suppliers, and all sub-contractors of the intent of these Specifications pertaining to the protection of vegetation. During the execution of his work, the Contractor shall use the same care and protection of all vegetation within his work area.

B. In areas where trees or shrubs may be damaged by construction equipment, the Contractor shall provide protective fencing, padding on tree trunks, tie-back branches or take other necessary actions to prevent damage to the trees, shrubs, or other vegetation. Damage to trees and shrubs shall include, but will not be limited to:

1. Bark damage to trees
2. Breakage of branches on trees or shrubs
3. Breaking or tearing of roots
4. Spilling toxic materials near the root zones
5. Spraying toxic materials on foliage
6. Fire damage to foliage and branches
7. Compaction of root areas under the drip line or damage by fill or storage of materials over the root zone
8. Foot or vehicular damage on low shrubs and groundcover

All damage shall be immediately reported to the Engineer who will file a report so that penalties may be determined.

A sum of \$50.00 per inch of diameter will be deducted from the monies due the Contractor for all trees that are removed which are not designated to be removed, or which do not have the written authorization of the Owners Representative for removal. The penalty is also applicable to trees damaged to the extent that such damage will, in the Owners Representative's opinion, cause the tree to die.

Contractor shall exercise caution when working near trees not designated to be removed, so that the trees will not be damaged. No root greater than 1 inch in diameter shall be cut unless it is necessary to do so during access road construction to reach the specified subgrade elevation.

1.04 JOB CONDITIONS

- A. Environmental requirements:
 - 1. No burning shall be permitted.
 - 2. Contractor shall be responsible for obtaining all necessary permits required for disposal of material resulting from clearing and grubbing operations.

PART 2 – PRODUCTS

Not Applicable

PART 3 - EXECUTION

3.01 CLEARING AND GRUBBING WORK REQUIRED

- A. Where required and directed by the Owners Representative, all trees, stumps, large roots, buried logs, decayed vegetable matter, heavy growth of grass and weeds and all other objectionable material shall be removed from the site of work. None of the above types of material will be allowed under fills, future roadways, or within ditch sections. Contractor should mow down grass and stockpile it prior to clearing and grubbing. The top layer of remaining weeds and grass should be scraped off along with a layer of top soil and stockpiled for use in landscaping areas. This stockpile should be sterilized and covered until redistributed into the landscape areas
- B. In the area to be grubbed and in areas required for excavation or buried pipelines, cutoff may be made at sufficient distance from the original ground surface as will facilitate grubbing for excavation operations.
- C. Trimming of trees and brush that overhang the right-of-way shall be accomplished as required to execute the work.
- D. Removal and disposal of material:

All of the debris type material resulting from the above clearing and other miscellaneous site clearing required by the work or any excavation shall be removed from the site of the work and deposited off site at the Contractor's disposal site.

Burning of any material will be permitted only if approval can be obtained from the various public bodies having authority or authorities in the areas concerned.

E. Stump removal:

Stump removal shall be performed in accordance with State Standard Specification, Section 16.

END OF SECTION

PART 1 GENERAL

1.01 DESCRIPTION

A. This Section includes the following:

1. Preparing subgrades for site improvements and paved and unpaved areas (excluding building pads) including removal of existing fill and other unsuitable soils, and their replacement with structural fill.
2. Excavating and backfilling for site areas, roads and utilities.
3. Subbase course for concrete walks and pavements.
4. Base course for asphalt paving.

B. Related Sections:

1. Section 31 09 13 – Site Conditions
2. Section 31 09 16 – Existing Underground Structures
3. Section 31 10 13 – Demolition/Debris Removal
4. Section 31 11 00 – Site Clearing and Grubbing
5. Section 31 23 15 – Shoring and Trench Safety
6. Section 31 23 17 – Trenching

C. References:

1. Requirements of General Conditions and Division 1 specifications apply to this section.
2. Document – A Geotechnical Engineering Report Update (MPE No. 04769-01; dated November 29, 2019) has been prepared for this site by Mid Pacific Engineering, Inc., Geotechnical Engineers. A copy is available for review at the office of Mid Pacific Engineering, Inc., 6310 State Highway 273, Anderson, California 96007.
3. California Standard Specifications – 2018

D. Existing power and telephone lines, trees, fences, pipelines or other conduits, embankments and structures in the vicinity of the work shall be supported and protected from injury by the Contractor during the construction and until the completion of the work.

E. A thorough attempt has been made to show the type, location, and number of all utilities, however, no guarantee is made as to the location and number of such utilities. The Contractor shall repair all utilities damaged in the progress of his work. The Contractor shall notify all owners of utilities of commencement of and sufficiently in advance to have the utilities mark the location of their facilities. The Contractor shall be prepared at all times with labor, equipment, and materials to make repairs on damaged mains or utilities.

F. No backfilling shall be done until the installation to be covered has been inspected and approved for covering. Compaction of backfill shall proceed immediately after backfilling.

1.02 DEFINITIONS

A. Backfill: Soil materials used to fill an excavation.

- B. Base Course: Layer placed between the subbase course and asphalt paving.
- C. Trench Bedding: Layer placed over the excavated subgrade in a trench before laying pipe.
- D. Trench Cover: Layer placed immediately over the pipe in trench.
- E. Borrow: Satisfactory soil imported from off-site for use as fill or backfill.
- F. Rock Drainage Course or Capillary Water Barrier: Layer supporting slab-on-grade used to minimize capillary flow of pore water.
- G. Excavation: Removal of material encountered above subgrade elevations.
 - 1. Additional Excavation: Excavation below subgrade elevations as directed by Owner's Representative. Additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
 - 2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated dimensions without direction by Owner's Representative. Unauthorized excavation, as well as remedial work directed by Owner's Representative, shall be without additional compensation.
- H. Fill: Soil materials used to raise existing grades.
- I. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
- J. Subbase Course: Layer placed between the subgrade and base course for asphalt paving, or layer placed between the subgrade and a concrete pavement or walk.
- K. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, rock drainage course, or topsoil materials.
- L. Utilities include on-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.
- M. Gravel Surface Course: Layer placed above the base course paving for gravel parking areas.

1.03 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Owners Representative and then only after arranging to provide temporary utility services according to requirements indicated.
- B. Wet Ground Areas: If wet areas are encountered during subgrade preparation or grading activities they should be subdrained or stabilized as directed by the Geotechnical Engineer.
- C. Seasonal Limits: Fill material shall not be placed, spread or rolled during unfavorable weather conditions. When the work is interrupted by heavy rains or snow, fill operations shall not be resumed until field tests indicate that the moisture contents of the subgrade and fill materials are satisfactory.

1.04 SUBMITTALS

- A. Excavation Protection Plan: Describe sheeting, shoring, and bracing materials and installation required to protect excavations and adjacent structures and property; include structural calculations to support plan.
- B. Samples: Submit 5-gallon bucket samples of each type of fill to Contractors testing laboratory. Submit test results to Engineer prior to incorporating material into construction.
- C. Materials Source: Submit name of imported fill (including but not limited to select fill, aggregate base, bedding, drain rock, and gravel surface course) materials supplier and sieve analysis.

1.05 QUALITY ASSURANCE

- A. Qualifications of workmen:
 - 1. Provide sufficient skilled workmen and supervisors who shall be present at all times during execution of this portion of the work and who shall be thoroughly familiar with the type of construction involved and the materials and techniques specified.
- B. Codes and standards:
 - 1. Wherever a test method is referenced in this Section, it shall be made in accordance with the most current test methods in use with ASTM Standards as listed below, unless noted otherwise:

<u>TEST</u>	<u>ASTM Test Procedure</u>
Relative Compaction	ASTM D1557
Specific Gravity	ASTM D854
In-place Density	ASTM D2922
Particle Size Analysis of Soils	ASTM D422
Plastic Limit and Plasticity Index	ASTM D4318
Soil Classification	ASTM D2487
In-place Moisture Content	ASTM D3017

1.06 TESTING

- A. The Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and to prepare test reports. The Contractor shall cooperate with the Owner's tester and/or inspector.

1.07 GRADES, LINES, LEVELS, AND PERMANENT MARKERS

- A. Staking:
 - 1. The Contractor is responsible for providing all surveying and staking for laying out the earthworks at the site based on bench marks shown on the plans.
- B. Responsibility for correctness:
 - 1. Contractor will be held responsible for the correctness of the layout and for establishing the location of possible buried utility lines. In the event there is any conflict between actual conditions and the drawings, Contractor shall notify the Owners Representative immediately and shall not proceed with the work until directed by the Owners Representative.

C. Preservation of markers:

1. All stakes, boundary lines, corner markers, bench marks or survey markers, etc., which have been or may be established in any part of the site, shall be carefully preserved and respected by the Contractor and shall be restored at the Contractor's expense if lost or destroyed as a result of his operations.

1.08 ACCURACY OF DATA

- A. Site data given herein and on the drawings are as exact as could be secured, but their absolute accuracy cannot be guaranteed. Exact locations, distances, elevations, etc., shall be finally governed by field conditions and the Engineer's instructions.
- B. The Contractor shall promptly, and before such condition is disturbed, notify the Owner in writing of soil or subsurface conditions which differ materially from those conditions shown in the Contract Documents or in the records of investigations of soil or subsurface conditions referred to above. The Owners Representative shall promptly investigate the conditions. If he finds the conditions materially different from those which reasonably should have been anticipated on the basis of a careful consideration of said records of investigations, logs of borings and examination of the site, and finds that said conditions will cause an increase or decrease in the cost of, and/or the time required for performance of the Contract, he will, after approval by the Owner, modify the Contract Terms in writing to provide for an equitable adjustment in cost and/or time of performance. Any claim of the Contractor shall not be allowed unless he has given the required written notice.

1.09 Archaeological Monitoring

- A. The Contractor shall notify the Owners Representative a minimum of 72 hours in advance of any excavation, and will not proceed with any excavation work until cleared to do so by the Owner. A Tribal monitor or archaeologist may be on site during construction activities. The contractor is advised that if any archaeological findings are discovered during construction that the monitor or archaeologist has the authority to slow or stop construction activities as they deem necessary.

PART 2 PRODUCTS

2.01 SOIL MATERIALS

- A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.
- B. Fill Quality: All fill materials should be composed of soil having a low expansion potential, and be free of organic content, debris, and/or other deleterious matter.
- C. Topsoil - Shall conform to Section 21-1.02D of the State Standard Specifications, and shall be a natural friable surface soil without admixtures of undesirable subsoil, refuse, asphalt, oils, metals, or foreign materials. It shall be reasonably free from roots, hard clay, coarse gravel, stones larger than two inch in any dimensions, noxious weeds, tall grass, brush, sticks or other material which would be detrimental to the proper development of vegetative growth. Native topsoil may be suitable for use as topsoil provided it meets the requirements above.

- D. Class 2 Aggregate Base: Class 2 aggregate base shall conform to the Caltrans Standard Specifications, State of California.
 - E. Select Fill/Engineered Fill: Should be free of organic matter, debris, or other deleterious matter, have a low expansion potential, and conform in general to the following requirements:
 - 1. All fill shall be of approved local materials from required excavations, supplemented by imported fill, if necessary. Approved local materials are defined as local granular soils free from significant quantities of rubble, rubbish and vegetation, and having been tested and approved by the Geotechnical Engineer prior to use. Clods, rocks or hard lumps exceeding three inches (3") in final size shall not be allowed in the upper two feet (2') of any fill supporting pavements and structures. Expansive clays shall not be used within the upper twelve inches (12") of the building pad or exterior flatwork subgrades, or subgrades supporting at-grade structures.
 - 2. Imported fill materials shall meet the above requirements; shall have plasticity indices not exceeding fifteen (15) when tested in accordance with ASTM D4318 test method; an Expansion Index less than twenty (20) when tested in accordance with ASTM D4829 test method; an R-value of 30 or greater when tested in accordance with California Test 301; shall be of three-inch (3") maximum particle size; and, shall be approved by the Geotechnical Engineer prior to transportation to the project site.
 - 3. Import fill shall be clean of contamination with appropriate documentation and shall have corrosion characteristics within acceptable limits. All imported materials shall be sampled, tested and approved by the Geotechnical Engineer prior to being transported to the site.
 - 4. Asphalt concrete, aggregate base, aggregate subbase, and other paving products shall comply with the appropriate provisions of the State of California (Caltrans) Standard Specifications, latest edition.
 - F. Trench Bedding and Cover: Bedding shall be crushed rock aggregate uniformly graded from No. 4 to 3/4-inch particle size. One hundred percent shall pass the 3/4-inch sieve and 95% shall be retained on the No. 4 sieve. Material shall have a minimum durability index of 35. Material shall be free of loam, organic material or vegetable matter. A minimum of 25% by weight shall be crushed particles.
 - G. Drain Rock: Free draining, durable, granular material meeting the requirements of Class 2 Permeable Material, per Caltrans Standard Specifications.
 - H. Gravel Surface Course: Gravel surface course shall be 3/4" minus well graded crushed rock with less than 5% of fines passing through a #200 sieve.
 - I. Geotextile Filter Fabric: 6 ounce/sq.yd., nonwoven.
 - J. Detectable Warning Tape: Polyethylene film warning tape encasing a metallic core, minimum 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility.
 - K. Satisfactory Native Backfill: Native material approved by the Geotechnical Engineer for use as backfill in utility trenches below paved or graveled areas.
- 2.02 OTHER MATERIALS
- A. All other materials not specifically described but required for proper completion of the work of this Section, shall be as selected by the Contractor subject to the approval of the Engineer.

2.03 MATERIAL APPROVAL

- A. Submit samples of materials and product data to Engineer for approval prior to placing orders. Samples shall be representative and be clearly marked to show the source of the material and the intended use on the project.

2.04 COMPACTION REQUIREMENTS

- A. The Contractor shall make all necessary excavations for compaction tests. Costs of excavating, backfilling, and compacting in connection with compaction testing shall be borne by the Contractor. Excavations for compaction tests shall be backfilled with material similar to that excavated and compacted to the specified density by the Contractor. Tests for compliance with Specifications, as determined by the Owners Representative, and as required in the specifications, will be made and paid for by the Contractor. The Contractor may also be required to pay for all required repeat tests in that area until the required results are obtained.

2.05 COMPACTION EQUIPMENT

- A. All compaction shall be by mechanical means unless the Contractor can demonstrate other means that will accomplish required compaction to the satisfaction of the Owner. Compaction equipment shall be of suitable type and adequate to obtain the densities specified and approved. Compaction equipment shall be operated in strict accordance with the manufacturer's instructions and recommendations. Equipment shall be maintained in such condition that it will deliver the manufacturer's rated compactive effort.

PART 3 EXECUTION

3.01 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, freezing temperatures or frost, and other hazards created by earthwork operations. Provide protective insulating materials as necessary.
- B. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.
- C. Prevent surface water and ground water from entering excavations, from ponding on prepared sub grades, and from flooding Project site and surrounding area.
- D. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

3.02 EXCAVATION

- A. Strip all existing improvements, pavements, debris, vegetation, root systems, dark colored organic rich topsoil, and disturbed/soft/loose soils.
- B. Temporary cut slopes – maximum slope of temporary cut slopes shall be determined by the Geotechnical Engineer.
- C. Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered, including rock, soil materials, and obstructions.

1. Contact the Owners Representative if excavated materials intended for fill and backfill include unsatisfactory soil materials and rock.

- D. Excavate for pavements, and walks to elevations and dimensions shown on the plans. Extend excavations for placing and removing concrete formwork, for installing services and other construction, and for inspections. Trim bottoms to required lines and grades to leave solid base to receive other work.

- E. Excavate utility trenches to indicated gradients, lines, depths, and invert elevations of uniform widths to provide a working clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit.

- F. Scarify, moisture condition, and recompact the upper 6 inches of subgrade soils. Uniformly moisture-condition to -1 to +3 percent of optimum and compact to at least 90 percent (95% in paved areas) relative compaction.

- G. When the moisture content of the subgrade is below that required to achieve the specified density, and that minimum content recommended in the geotechnical report, water shall be added until the proper moisture content is achieved.

- H. When the moisture content of the subgrade is too high to permit the specified compaction to be achieved, the subgrade shall be aerated by blading or other methods until the moisture content is satisfactory for compaction.

- I. After the foundations for fill have been cleared, plowed or scarified, they shall be disced or bladed until uniform and free from large clods, brought to the proper moisture content and compacted to not less than ninety percent (90%) of the maximum dry density as determined by the ASTM D1557-91 Compaction Test. Soils compaction shall be performed using a heavy, self-propelled sheepsfoot compactor (Caterpillar CS56B or equivalent size). Compaction operations shall be performed in the presence of the Geotechnical Engineer who will evaluate the performance of the materials under compactive load. Wet, soft or unstable soil deposits, as determined by the Geotechnical Engineer, shall be excavated to depths that expose a firm base and grades restored with engineered fill in accordance with these specifications

- J. Subgrade preparation and compaction shall extend at least five feet (5') beyond the proposed structure or fill boundary lines, or as required by the Geotechnical Engineer based on the exposed soil and site conditions.

- K. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities.

- L. Contractor shall contact and coordinate with the Geotechnical Engineer to review the exposed subgrade surfaces for recommendations on suitability of exposed subgrade. The Geotechnical Engineer will evaluate the subgrade for additional material to be stripped based on in place soil density testing or proof rolling of the sub grade.

- M. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom with structural fill, without altering top elevation.
 1. Fill unauthorized excavations under other construction or utility pipe as directed by the Owner.

- N. Stockpile borrow materials and satisfactory soil materials, without intermixing, in shaped, graded, drained, and covered stockpiles. Stockpile soil materials away from edge of excavations and outside drip line of any remaining trees.
- O. Cut ditches/swales accurately to the cross sections and grades shown. Take care not to over-excavate ditches, and backfill excessive excavation to grade. Trim all roots, stumps, rock and other foreign matter from the sides and bottom of the ditches. Compact the surfaces of ditch slopes and bottom.
- P. Groundwater may be encountered within the planned excavation depth, including utility trenches. Dewatering may be necessary to accomplish required excavations. The Contractor is responsible for design, operation and maintenance of all temporary dewatering system subject to approval of the Engineer.

3.03 BACKFILLS AND FILLS

- A. Utility Trench Backfill: Place, compact, and shape bedding course to provide continuous support for pipes and conduits over rock and other unyielding bearing surfaces and to fill unauthorized excavations.
- B. Install warning tape directly above all utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.
- C. Fill: Place and compact structural fill as shown on the construction documents and as directed by the Geotechnical Engineer in layers to required elevations.
- D. Cut and fill slopes shall be constructed at slope gradient of 3:1 (horizontal to vertical) or flatter, unless approved by the Geotechnical Engineer in specific areas.
- E. Construct fill slopes by overfilling and cutting the slope to final grade. The Geotechnical Engineer shall observe in the field permanent cut slopes to verify that the exposed soil conditions are as anticipated.
- F. Uniformly moisten or aerate subgrade and each subsequent fill or backfill layer before compaction to optimum moisture content. If compaction is not achieved, remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content and is too wet to compact to specified dry unit weight.
- G. Compaction: Place backfill and fill materials in layers not more than 6 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

- H. Compact fill material according to the following (moisture content shall be from -1 to +3 percent optimum):

Location	Compacting Requirements	Test Method
Beneath Floor Slab	90%	ASTM D1557
Supporting Footings	90%	ASTM D1557
Within 6 inches of Base of Asphalt Pavement	95%	Caltrans Test Method Cal 216 and 231 or ASTM D1557
Top 12 inches of utility trenches within pavement areas	95%	ASTM D1557
Utility trenches beneath landscape areas	85% - 90%	ASTM D1557

- I. Grading: Uniformly grade areas to a smooth surface, free from irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated. Grade unpaved subgrades to tolerances of plus or minus 1 inch and pavements and paved areas to plus or minus 1/2 inch.
- J. Subbase and Base Courses: Under vehicle pavements, sidewalks, walkways and slabs, place subbase course on prepared subgrade. Place base course material over subbase. Compact to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry density according to ASTM D 1557, including the upper 6 inches of the soil subgrade supporting the subbase and/or the baserock as shown in the table in Section 3.03H.
- K. Building Areas: See Structural Drawings and Specifications.
- L. Fill in lifts allowing time for Contractors materials tester to test each lift for compaction.
- M. Compaction of fill materials by flooding, ponding, jetting or track walking will not be permitted.

3.04 OBSERVATION

- A. Grading operations shall be observed by the Geotechnical Engineer, serving as the representative of the Owner.
- B. Field density tests shall be made by the Contractor after compaction of each layer of fill. Additional layers of fill shall not be spread until the field density tests indicate that the minimum specified density has been obtained.
- C. Earthwork shall not be performed without the notification or approval of the Geotechnical Engineer. The Contractor shall notify the Geotechnical Engineer at least two (2) working days prior to commencement of any aspect of the site earthwork.
- D. If the Contractor should fail to meet the technical or design requirements embodied in this document and on the applicable plans, the Contractor shall make the necessary readjustments until all work is deemed satisfactory, as determined by the Geotechnical Engineer and the Project Design Engineer. No deviation from the specifications shall be made except upon written approval of the Geotechnical Engineer or Project Design Engineer.

3.05 FIELD QUALITY CONTROL

- A. Inspections and Testing Agency: The Contractor shall engage a qualified independent testing and inspecting agency to perform field tests and inspections and to prepare test reports.

- B. Contractor shall allow testing agency to test and inspect subgrades and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.
- C. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; recompact and retest until specified compaction is obtained.
- D. Additional testing, at Contractor's expense, will be performed to determine compliance of corrected Work with specified requirements.
- E. When test results indicate, as determined by the Engineer, that compaction is not as specified, the material shall be re-compacted to meet specification requirements. Tests on re-compacted areas shall be performed to determine conformance with specification requirements.
- F. Inspections and test results shall be certified by the Contractor's laboratory. These certifications shall state that the tests and observations were performed by or under the direct supervision of the engineer and that the results are representative of the materials or conditions being certified by the tests.
- G. The following number of tests, if performed at the appropriate time, will be the minimum acceptable for each type operation.
 - 1. In-Place Densities
 - a. One test per 100 linear feet of roadway, or fraction thereof, of each lift.
 - b. One test per 100 square feet, or fraction thereof, of each lift of fill or backfill areas compacted by hand-operated machines.
 - c. One test per 500 square feet, or fraction thereof, of each lift of fill or backfill areas compacted by other than hand-operated machines.
 - d. As directed by the Engineer or Owner.

3.06 PROTECTION AND DISPOSAL

- A. Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.
- B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction.
- C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
- D. Disposal: Remove waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property.

END OF SECTION

PART 1 GENERAL

1.01 DESCRIPTION

A. Work included:

Shoring required for general safety, worker protection and protection of adjacent property from the hazards of caving ground. Includes:

1. Trench excavations
2. Structural excavations

B. Related requirements and work described elsewhere includes:

1. Requirements of General Conditions and Division 1 apply to all work in this Section.
2. Division 2 sections pertaining to site conditions, earthwork, trench excavation and backfill.

1.02 CONTRACTOR'S RESPONSIBILITIES FOR SAFETY

- A. The Contractor shall be solely and completely responsible for conditions of the job site, including safety of all persons (including employees) and property during performance of the work. This requirement shall apply continuously and not be limited to normal working hours.
- B. Safety provisions shall conform to U.S. Department of Labor (OSHA), the California Occupational Safety and Health Act, and all other applicable Federal, State, county, and local laws, ordinances, codes, the requirements set forth below, and any regulations that may be detailed in other parts of these Specifications.
- C. Where any of these are in conflict, the more stringent requirement shall be followed.

1.03 PERMIT

- A. For trenches or excavations of depth five feet or deeper, the Contractor shall obtain from the State Division of Industrial Safety a permit for such excavation; submit a copy of the permit to the Engineer, prior to initiating any work requiring said permit.

1.04 SAFETY ORDERS

- A. The Contractor shall have at the worksite, copies or suitable extracts of the Construction Safety Orders of Cal-OSHA.
- B. All work shall comply with the provisions of these and all other applicable laws, ordinances and regulations.

1.05 TRENCH SAFETY PLAN

- A. For trenches and excavations 5 feet or more in depth, the Contractor shall submit to Owners Representative a detailed plan design of shoring, bracing, sloping, or other provisions to be made for worker protection from the hazards of caving ground.
- B. Such plan shall be submitted at least 10 days before the Contractor intends to begin trenching or excavation work.

- C. If such plan varies from the shoring system standards established by the Construction Safety Orders, the plan shall be prepared, sealed and signed by a civil or structural engineer registered in California. Signed and sealed copies of calculations necessary to qualify the system shall be submitted also.
- D. Nothing herein shall be deemed to allow the use of shoring, sloping, or protective system less effective than that required by the Construction Safety Orders of the Division of Industrial Safety.

1.06 CONTRACTOR'S SUPERVISOR

- A. The Contractor shall appoint a qualified supervisory employee who shall be responsible to determine the shoring system which shall be used depending on local soil type, water table, etc.
- B. This supervisor shall have a minimum of five years experience in the directing of such excavation and shoring work.

1.07 PAYMENT

- A. Payment for all work called for in this section will be considered as included with other bid prices. No separate compensation will be allowed.

END OF SECTION

PART 1 GENERAL

1.01 DESCRIPTION

A. Section Includes:

1. Excavating trenches for utilities from 5 feet outside building to utility service.
2. Compacted fill from top of utility bedding to subgrade elevations.
3. Backfilling and compaction.

B. Related Sections:

1. Section 31 09 13 – Site Conditions
2. Section 31 23 15 – Shoring and Trench Safety
3. Section 31 20 00 – Earth Moving
4. Section 33 11 16 - Site Water Utility Distribution Piping

Requirements of the General Conditions and Division 1 apply to this Section.

1.02 REFERENCES

A. ASTM International:

1. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
2. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort 12,400 ft-lbf/ft³.
3. ASTM D1556 - Standard Test Method for Density of Soil in Place by the Sand-Cone Method.
4. ASTM D1557 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort 6,000 ft-lbf/ft³.
5. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
6. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
7. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

1.03 DEFINITIONS

- A. Utility:** Any buried pipe, duct, conduit, or cable.

1.04 SUBMITTALS

- A. Excavation Protection Plan: Describe sheeting, shoring, and bracing materials and installation required to protect excavations and adjacent structures and property; include structural calculations to support plan if shoring is required per OSHA Requirements.
- B. Samples: Submit 5-gallon bucket samples of each type of fill to testing laboratory.
- C. Materials Source: Submit name of all materials suppliers and sieve analysis.

1.05 QUALITY ASSURANCE

- A. Perform Work in accordance with local standards.
- B. Maintain one copy of each document on site.

1.06 QUALIFICATIONS

- A. Prepare excavation protection plan, if required by OSHA, under direct supervision of Professional Engineer experienced in design of this Work and licensed in State of California.

1.07 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.08 COORDINATION

- A. Verify Work associated with lower elevation utilities is complete before placing higher elevation utilities.

PART 2 (NOT USED)

PART 3 EXECUTION

3.01 LINES AND GRADES

- A. Lay pipes to lines and grades indicated on Drawings.
 - 1. Owner reserves right to make changes in lines, grades, and depths of utilities when changes are required for Project conditions.
- B. Use laser-beam instrument with qualified operator to establish lines and grades.

3.02 PREPARATION

- A. Call Local Underground Service Alert not less than two working days before performing Work.
 - 1. Request underground utilities to be located and marked within and surrounding construction areas.
- B. Identify required lines, levels, contours, and datum locations.
- C. Protect plant life, lawns, and other features remaining as portion of final landscaping.

- D. Protect bench marks, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.
- E. Maintain and protect above and below grade utilities indicated to remain.
- F. Establish temporary traffic control when trenching is performed in public right-of-way. Relocate controls and reroute traffic as required during progress of Work.

END OF SECTION

PART 1 GENERAL

1.1 DESCRIPTION

- A. Section Includes:
 - 1. Aggregate base course.

1.2 REFERENCES

- A. ASTM:
 - 1. D1557: Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,0000 ft-lbf/ft³)
 - 2. D6938: Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods. (Shallow Depth)
 - 3. D2940: Standard Specification for Graded Aggregate Material for Bases and Subbases for Highways and Airports.
- B. California Department of Transportation Standard Specifications (2010 edition)
Section 26 Aggregate Bases

1.3 SUBMITTALS

- A. Samples: In air-tight containers, 10 lb. sample of each type of aggregate fill to testing laboratory.
- B. Materials Source: Name of aggregate materials suppliers.
- C. Manufacturer's Certificate: Products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

- A. Furnish each aggregate material from single source throughout Work.
- B. Perform Work according to State of California Department of Transportation standards.

PART 2 PRODUCTS

2.1 AGGREGATE MATERIALS

- A. Base Aggregate: ASTM D2940; graded type. (3/4 inch maximum)

Sieve Size	Percent Passing
2 inches	--
1-1/2 inches	--
1 inch	70 to 92
3/4 inches	90-100
No. 4	35 - 60
No. 30	10 - 30
No. 200	2 -9

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify compacted substrate is dry and ready to support paving and imposed loads.
 - 1. Proof-roll substrate with loaded 10-wheel dump truck in minimum two perpendicular passes to identify soft spots.
 - 2. Remove soft substrate and replace with compacted fill as specified in Section 31 23 23.
- B. Verify substrate has been inspected, gradients and elevations are correct.

3.2 PREPARATION

- A. Correct irregularities in substrate gradient and elevation by scarifying, reshaping, and re-compacting.
- B. Do not place fill on soft, muddy, or frozen surfaces.

3.3 AGGREGATE PLACEMENT

- A. Place aggregate two equal thickness layers to total compacted thickness of eight (8) inches. Maximum Layer Compacted Thickness: 4 inches.
- B. Roller compact aggregate to 95 percent maximum density.
- C. Level and contour surfaces to elevations, profiles, and gradients indicated.
- D. Maintain optimum moisture content of fill materials to attain specified compaction density.
- E. Use mechanical tamping equipment in areas inaccessible to compaction equipment.

3.4 TOLERANCES

- A. Maximum Variation From Flat Surface: 0.05 foot measured with 10 foot straight edge.
- B. Maximum Variation From Thickness: 0.05 foot.

3.5 FIELD QUALITY CONTROL

- A. Compaction testing will be performed according to ASTM D6938.
- B. When tests indicate Work does not meet specified requirements, remove Work, replace and retest.
- C. Frequency of Tests: One test for every 5,000 square feet of each layer compacted aggregate.
- D. Submit test results to Engineer for acceptance.

3.6 COMPACTION

- A. Compact materials to 95 percent of maximum density.

END OF SECTION

PART 1 GENERAL

1.01 DESCRIPTION

A. This Section includes the following:

1. Hot-mix asphalt (HMA) paving using the STANDARD construction process. Work to be performed under this Section covers all labor, materials, tools, equipment, transportation, testing and incidentals necessary to construct asphalt concrete pavements. This shall include asphalt concrete overlays and leveling courses.

B. Related Sections:

1. Section 31 09 13 – Site Conditions
2. Section 31 20 00 – Earth Moving

1.02 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. California Department of Transportation Standard Specifications – 2018

1.03 SYSTEM DESCRIPTION

- A. Provide HMA pavement according to the materials, workmanship, and other applicable requirements of the California Standard Specifications.

1.04 SUBMITTALS

- A. Product Data: For each product specified. Include technical data and tested physical and performance properties.
- B. HMA Job Mix Formula (JMF): For each HMA mix proposed for the Work in accordance with Section 39.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced installer who has completed hot-mix asphalt paving similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.
- B. Manufacturer Qualifications: Engage a firm experienced in manufacturing hot-mix asphalt similar to that indicated for this Project and with a record of successful in-service performance.
 1. Firm shall be a registered and approved paving mix manufacturer with Caltrans.

1.06 PROJECT CONDITIONS

- A. Environmental Limitations: Do not apply asphalt materials if substrate is wet or excessively damp or if the following conditions are not met:
 1. Prime and Tack Coats: Minimum surface temperature of 50 deg F.
 2. Asphalt Surface Course: Minimum surface temperature of 50 deg F at time of placement.

2.01 AGGREGATES

- A. Use aggregates per Caltrans, Section 39, for ½" sieve size target value for Type A asphalt concrete.

2.02 ASPHALT MATERIALS

- A. Binder Type The asphalt grade shall be PG 64-16 conforming to Section 92, "Asphalts", of the State Standard Specifications.
- B. Tack coat shall be emulsified asphalt Grade RS-1, RS-1h, SS-1, or SS-1h and shall conform to Section 94, "Asphaltic Emulsions", of the State Standard Specifications.
- C. Water: Potable.

2.03 AGGREGATE BASE

- A. Use class 2 Aggregate Base per Caltrans, Section 26.

2.04 AUXILIARY MATERIALS

- A. Sand: ASTM D 1073, Grade Nos. 2 or 3.
- B. Pavement-Markings and Stripes:
 - 1. Thermoplastic per Caltrans Standard Specifications, color as indicated.
 - 2. Paint per Caltrans Standard Specifications, color as indicated.

2.05 MIXES

- A. Hot-Mix Asphalt: Provide dense, hot-laid, hot-mix asphalt plant mixes per Caltrans, Section 39, Type A, asphalt concrete.

2.06 SLURRY SEAL

- A. Use Type I aggregate per Caltrans, Section 37.

PART 3 EXECUTION

3.01 SUBGRADE PREPARATION

- A. Verify that subgrade is dry and in suitable condition to support paving and imposed loads. Wet ground encountered during subgrade preparation should be subdrained as directed by the Geotechnical Engineer.
- B. Compact 6 inches of subgrade material to 95% relative compaction based on ASTM D-1557 and minimum 90% relative compaction per ASTM D-1557 in any compacted structural fill or subgrade below.
- C. If difficult conditions exist and it is difficult to obtain compaction as directed in paragraph B above, excavate subgrade a minimum 0.25 feet lower in elevation and compact to 90% relative compaction per ASTM D-1557 or demonstrate that the surface is non-yielding (not pumping or weaving) under proofrolling with a loaded 10-cubic-yard dump truck or equivalent, place a layer of

6 ounces per square yard woven geo-synthetic fabric and place an additional 0.25 feet of granular base compacted to 95% relative compaction per ASTM D-1557.

- D. Notify Owners Representative in writing of any unsatisfactory conditions. Do not begin paving installation until these conditions have been satisfactorily corrected.

3.02 SURFACE PREPARATION

- A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

- 1. Sweep loose granular particles from surface of unbound-aggregate base course. Do not dislodge or disturb aggregate embedded in compacted surface of base course.

- B. Tack Coat: Apply uniformly between HMA layers, curbs, gutters and construction joints in accordance with Section 39 the Standard Specifications. Apply enough material in 1 coat to penetrate and seal, but not flood, surface. Allow tack coat to cure as required.

- 1. Protect coated surfaces from damage until ready to receive paving.

3.03 HOT-MIX ASPHALT PLACING

- A. Machine place HMA on prepared surface, spread uniformly, and strike off. Place HMA by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness, when compacted.

- 1. Place HMA surface course in accordance with Section 39, and in lifts no thicker than 0.25 feet.
 - 2. Spread mix at minimum temperature of 250 deg F.
 - 3. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes, unless otherwise indicated.
 - 4. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

- B. Place paving in consecutive strips not less than 10 feet wide, except where infill edge strips of a lesser width are required.

- C. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete asphalt base course for a section before placing asphalt surface course.

- D. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.04 JOINTS

- A. Construct joints to ensure continuous bond between adjoining paving sections. Construct joints free of depressions with same texture and smoothness as other sections of hot-mix asphalt course.

- 1. Clean contact surfaces and apply tack coat.
 - 2. Offset longitudinal joints in successive courses a minimum of 6 inches.
 - 3. Offset transverse joints in successive courses a minimum of 24 inches.

4. Construct transverse joints by bulkhead method or sawed vertical face method as described in AI's "The Asphalt Handbook."
5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
6. Compact asphalt at joints to a density within 2 percent of specified course density.

3.05 COMPACTION

- A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or vibratory-plate compactors in areas inaccessible to rollers.
- B. Breakdown Rolling: Accomplish breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Repair surfaces by loosening displaced material, filling with hot-mix asphalt, and rerolling to required elevations.
- C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling, while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:
 1. Average Density: 96 percent of reference laboratory density according to ASTM D 1559, but not less than 94 percent nor greater than 100 percent.
 2. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent nor greater than 96 percent.
- D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.
- E. Repairs: Remove paved areas that are defective or contaminated with foreign materials. Remove paving course over area affected and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.
- F. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.
- G. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.06 INSTALLATION TOLERANCES

- A. Where trenching damages existing pavement, the pavement and aggregate base must be replaced to match the existing grades and thicknesses. Minimum thickness for asphalt roads or driveways shall be 0.3-feet asphalt over 0.60-feet aggregate base. Minimum thickness for concrete roads or driveways shall be 6-inch concrete with #4 bars at 18-inch centers each way over 6-inch aggregate base.
- B. Thickness: Compact each course to produce the thickness indicated within the following tolerances:
 1. Base Course: Plus or minus 1/2 inch.
 2. Surface Course: Plus 1/4 inch, no minus.
- C. Surface Smoothness: Section 39-1.12

3.07 PAVEMENT MARKINGS

- A. Where trenching damages existing pavement markings, replace to match existing conditions. Raised markers shall conform to Caltrans Standard Specifications Section 85.
- B. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Engineer.
- C. Allow paving to cure for 30 days before starting pavement marking.
- D. Sweep and clean surface to eliminate loose material and dust.
- E. Apply stripes and markings with mechanical equipment to produce pavement markings of dimensions indicated with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

3.08 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing agency to perform field inspections and tests and to prepare test reports.
 - 1. Testing agency will conduct and interpret tests and state in each report whether tested Work complies with or deviates from specified requirements.
- B. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.
- C. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances in accordance with Section 39.
- D. Density Testing: Density cores and testing shall be in accordance with Section 39 Samples of uncompacted paving mixtures and compacted pavement will be secured by testing agency according to California Test 308, Method A.
 - 1. Reference laboratory density will be determined by averaging results from 4 samples of HMA delivered daily to site and compacted according to the HMA JMF.
 - 2. Reference maximum theoretical density will be determined by averaging results from 4 samples of HMA delivered daily to site and compacted according to the HMA JMF.
 - 3. In-place density of compacted pavement will be determined by testing core samples according to California Test 308, Method A.
 - a. One core sample will be taken for every 1000 sq. yd. or less of installed pavement, but in no case will fewer than 3 cores be taken.
 - b. Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D 2950 and correlated with ASTM D 1188 or ASTM D 2726.
- E. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes

1. This work consists of furnishing, placing and finishing commercial grade concrete curbs, gutters islands, traffic separators, driveways, walks, sidewalks, vehicle slabs, and miscellaneous surfaces.

B. Related Sections

1. Section 31 20 00 – Earth Moving
2. Section 32 12 16 – Asphalt Paving

1.02 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials:

1. AASHTO M324 - Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements.

B. American Concrete Institute:

1. ACI 301 - Specifications for Structural Concrete.
2. ACI 304 - Guide for Measuring, Mixing, Transporting, and Placing Concrete.

C. ASTM International:

1. ASTM A185/A185M - Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.
2. ASTM C31/C31M - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
3. ASTM C33 - Standard Specification for Concrete Aggregates.
4. ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
5. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete.
6. ASTM C143/C143M - Standard Test Method for Slump of Hydraulic Cement Concrete.
7. ASTM C150 - Standard Specification for Portland Cement.
8. ASTM C172 - Standard Practice for Sampling Freshly Mixed Concrete.
9. ASTM C173/C173M - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
10. ASTM C231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
11. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete.
12. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
13. ASTM C494/C494M - Standard Specification for Chemical Admixtures for Concrete.
14. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete.
15. ASTM C979 - Standard Specification for Pigments for Integrally Colored Concrete.
16. ASTM C989 - Standard Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars.
17. ASTM C1017/C1017M - Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete.
18. ASTM C1064/C1064M - Standard Test Method for Temperature of Freshly Mixed Hydraulic-

Cement Concrete.

19. ASTM C1116 - Standard Specification for Fiber-Reinforced Concrete and Shotcrete.
20. ASTM C1315 - Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.
21. ASTM C1371[-2004a] - Standard Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emisometers.
22. ASTM C1549[-2004] - Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer.
23. ASTM D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
24. ASTM D1752 - Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
25. ASTM D6690 - Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements.
26. ASTM E408[-1971(1996)e1] - Standard Test Methods for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques.
27. ASTM E903[-1996] - Standard Test Method for Solar Absorptance, Reflectance, and Transmittance of Materials Using Integrating Spheres.
28. ASTM E1918[-1997] - Standard Test Method for Measuring Solar Reflectance of Horizontal and Low-Sloped Surfaces in the Field.
29. ASTM E1980[-2001] - Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces.

1.03 SUBMITTALS

- A. General: Submit the following according to the conditions of the contract and Division 1 of the specification sections.
- B. Product data for proprietary materials and items, including reinforcement and forming accessories, admixtures, joint systems, curing compounds, dry-shake finish materials, and other data.
- C. Mill Test reports for each heat or melt of steel.
- D. Design mixes for each class of concrete. Include revised mix proportions when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments.
- E. Laboratory test reports for evaluation of concrete materials and mix design tests.
- F. Color samples of integral concrete admixture. Color to be selected by Owner's representative.
- G. Colored or Stamped Concrete Jobsite Sample: Provide a 4' x 4' square jobsite sample of concrete flatwork with integral color admixture. Sample shall be reviewed and approved by Owners Representative before any colored concrete is installed. Sample shall remain on the jobsite throughout the duration of the project for comparison purposes.

1.04 QUALITY ASSURANCE

- A. Concrete Standards: Comply with provisions of the following standards, except where more stringent requirements are indicated.
 1. American Concrete Institute (ACI) 301, "Specifications for Structural Concrete for Buildings."
 2. ACI 318, "Building Code Requirements for Reinforced Concrete."

- 3. Concrete Reinforcing Steel Institute (CRSI) "Manual of Standard Practice."
 - B. Concrete Manufacturer Qualifications: Manufacturer of ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment.
 - C. Concrete Testing Service: Engage a qualified independent testing agency to perform materials evaluation tests and to design concrete mixes.
- 1.05 1.03 WARRANTY
- A. Warranty shall provide for repairing and replacing, at no cost to Owner, joint sealants which fail because of leaking, crumbling, hardening, shrinkage, bleeding, splitting, sagging, staining or loss of adhesion within 2 years of substantial completion of work.
- 1.06 DELIVERY, STORAGE AND HANDLING
- A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use.
 - B. Store reinforcing material in manner to prevent excessive rusting and fouling with grease, dirt, or other bond-weakening coatings.
 - C. Take precautions to maintain identification of reinforcing material after bundles are broken.
- 1.07 SCHEDULING AND SEQUENCING
- A. Plan erection and removal to permit proper sequence of concrete placing without damage to concrete.
- 1.08 PROJECT CONDITIONS
- A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.
 - B. Temperature and Weather Requirements
 - 1. Do not place concrete when temperature or weather will affect performance or appearance of concrete.
 - 2. Minimum Ambient Temperature: 40°F
 - 3. Precipitation: None expected before concrete can be finished and protected.
 - C. Substrate Requirements
 - 1. Do not place concrete on muddy or frozen substrate.
 - 2. Remove mud, dirt, and ice from formwork surface.

PART 2 PRODUCTS

2.01 FORMS

- A. Design of the formwork is the Contractor's responsibility.
- B. Form Materials: Plywood, metal, metal-framed plywood, or other acceptable panel-type materials to provide full-depth, continuous, straight, smooth exposed surfaces. Use flexible or curved forms for curves of a 100-foot or less radius.

- C. Form Release Agent: Provide commercial formulation form-release agent with a maximum of 350 g/L volatile organic compounds (VOCs) that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
- D. Forms and Formwork Accessories
 - 1. Exposed Plywood Forms: Plyform, Class I or II.
 - 2. Lumber and Steel Forms: Smooth face lumber or steel
 - 3. Chamfer Strip: radius per drawings
 - 4. Steel Pipe Sleeves: ASTM A 53
 - 5. Expansion and Isolation Joint Fillers: Granulated cork, 1/2-inch thick, ASTM D 1752, Type II
 - 6. Form Joint Tape: Closed cell PVC foam with pressure sensitive adhesive on one side.

2.02 REINFORCING MATERIALS

- A. Reinforcing Bars and Tie Bars: ASTM A 615, Grade 60, deformed.
- B. Joint Dowel Bars: Plain steel bars, ASTM A 615, Grade 60. Cut bars true to length with ends square and free of burrs.
- C. Hook Bolts: ASTM A 307, Grade A bolts, internally and externally threaded. Design hook bolt joint assembly to hold coupling against pavement form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.
- D. Supports for Reinforcement: Chairs, spacers, dowel bar supports and other devices for spacing, supporting, and fastening reinforcing bars, welded wire fabric, and dowels in place. Use wire bar-type supports complying with CRSI specifications.
 - 1. Use supports with sand plates or horizontal runners where base material will not support chair legs.
- E. Welded Wire Fabric: ASTM A185/A185M; in flat sheets or coiled rolls; unfinished.

2.03 CONCRETE MATERIALS

- A. Cement: Portland conforming to ASTM C150 Type II
- B. Coarse Aggregate: ASTM C33, clean hard, durable uncontaminated, washed, graded, cleaned and screened. Crusher run stone or bank run gravel will not be permitted. Maximum size not to exceed 75% of clear spacing between reinforcement.
 - 1. Size No. 467 (1 1/2" to No. 4) for footings, foundations, walls not less than 8" thick, slabs on grade or fill and steel reinforced slabs not less than 6" thick.
 - 2. Size No. 67 (3/4" to No. 4): for other site concrete, including curbs, gutters and sidewalks.
 - 3. Do not use coarse aggregates that contain substances that cause spalling.
- C. Fine aggregate: ASTM C33, natural sand with minimum 15% passing No. 50 sieve, minimum 3% passing No. 100 sieve and fineness modulus 2.0 to 3.0.
 - 1. Do not use fine aggregates that contain substances that cause spalling.

- D Exposed Aggregate Finish Aggregates: Provide 1/8" – 1/4" smooth, clean, washed pea-gravel aggregate if specified on plans.
- E Water: Potable.
- F Concrete Reinforcing Fibers: ASTM C1116, high strength industrial-grade fibers specifically engineered for secondary reinforcement of concrete. Tensile strength 130 ksi; toughness 15 ksi; 0.75 inch long fibers, 34 million/lb fiber count.

2.03 MINOR CONCRETE MIX

- A Mix concrete in accordance with ASTM C94. Use a homogeneous mixture throughout. Concrete to have 2,800 psi compressive strength at 28 days. Proportion to ACI 211.1 or to ACI 318 based on past strength performance. Cement content to be 470 pounds (5 sacks) per cubic yard, minimum.
- B Slump: 2" minimum to 4" maximum.
- C Air Entrainment
 - 1. 5 percent ± 1 percent.
- D Pumped concrete: Per ACI 304.
- E Adjustment to Concrete Mixes: Mix design adjustments may be requested by Contractor when characteristics of materials, project conditions, weather, test results, or other circumstances warrant.

2.04 ADMIXTURES

- A Admixtures containing more than 0.05% chloride ions not permitted. No calcium chloride permitted.
- B Air entrainment: ASTM C260 certified by manufacturer to be compatible with other required admixtures.
- C Water reducing admixture: ASTM C494 Type D.
 - B. Coloring Admixtures (if specified on drawings):
 - 1. Color: As directed by Architect
 - 2. Finish: As directed by Architect

2.05 BONDING AGENT

- A Site concrete bonding agent, Acrylic ASTM C932.

2.06 EXPANSION JOINTS SEALANT

- A Premolded Joint Filler:
 - 1. Multi component polyurethane sealant
 - 2. ASTM C920
 - 3. Shore hardness 35 or greater
- B Acceptable products include Tremco THC-900 or equal.

- C Color to match adjacent concrete.

2.07 MISCELLANEOUS JOINT MATERIALS

- A Primer: Non-staining, as recommended by sealant manufacturer.
- B Backer rod shall be flexible and compressible, formed from
 1. closed-cell foam polyurethane or
 2. butyl rubber or
 3. open and closed-cell polyurethane.
- C Bond breaker tape: polyurethane 4-6 mil thick, pressure sensitive.

2.08 CURING COMPOUND

- A ASTM C309 TYPE 1 class B which will not discolor concrete nor affect bonding of other finishes.
- B Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 9 oz per SY, complying with AASHTO M182, Class 2.
- C Moisture-Retaining Cover: One of the following, complying with ASTM C 171.
 1. Waterproof paper.
 2. Polyethylene film.
 3. White burlap-polyethylene sheet.
- D Evaporation Control: Monomolecular film-forming compound applied to exposed concrete slab surfaces for temporary protection from rapid moisture loss.

2.09 RELATED MATERIALS

- A Epoxy Adhesive: ASTM C 881, two-component material suitable for dry or damp surfaces. Provide material type, grade, and class to suit requirements.
- B Non shrink grout shall
 1. be premixed compound.
 2. be a blend of non metallic aggregate, cement, water reducing and plasticizing agents.
 3. have compressive strength 2,400 psi in 2 days.
 4. have compressive strength 7,000 psi in 28 days.

PART 3 EXECUTION

3.01 GENERAL

- A. All curbs, gutters and sidewalks construction shall conform to the plans and these specifications.

3.02 SURFACE PREPARATION

- A. Proof-roll prepare subbase surface to check for unstable areas and verify need for additional compaction. Do not begin paving work until such conditions have been corrected and are ready to receive paving.
- B. Remove loose material from compacted subbase surface immediately before placing concrete.

3.03 EDGE FORMS AND SCREED CONSTRUCTION

- A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for paving to required lines, grades, and elevations. Install forms to allow continuous progress of work and so that forms can remain in place at least 24 hours after concrete placement.
- B. Check completed formwork and screeds for grade and alignment to following tolerances:
 - 1. Top of Forms: Not more than 1/8 inch in 10 feet.
 - 2. Vertical Face on Longitudinal Axis: Not more than 1/4 inch in 10 feet.
- C. Clean forms after each use and coat with form release agent as required ensuring separation from concrete without damage.

3.04 PLACING REINFORCEMENT

- A. General: Comply with Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars" for placing and supporting reinforcement.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.
- C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.
- D. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.
- E. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities or replace units as required before placement. Set mats for a minimum 2 inch overlap to adjacent mats.

3.05 JOINTS

- A. General: Construct contraction, construction, and isolation joints true to line with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to the centerline, unless indicated otherwise.
 - 1. When joining existing paving, place transverse joints to align with previously placed joints, unless indicated otherwise.
- B. Contraction Joints: Provide weakened-plane contraction joints, sectioning concrete into areas as shown on Drawings.
 - 1. Tooled Joints: Form contraction joints in fresh concrete by grooving and finishing each edge of joint with a radiused jointer tool.
 - 2. Locate expansion joints at intervals of 4 feet, unless indicated otherwise.
- C. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than 1/2 hour, unless paving terminates at isolation joints.
 - 1. Continue reinforcement across construction joints unless indicated otherwise. Do not continue reinforcement through sides of strip paving unless indicated.
 - 2. Provide tie bars at sides of paving strips where indicated.

- D. Expansion Joints: Form expansion joints of preformed joint filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.
1. Locate expansion joints at intervals of 20 feet, unless indicated otherwise.
 2. Extend joint fillers full width and depth of joint, not less than 1/2 inch or more than 1 inch below finished surface where joint sealant is indicated. Place top of joint filler flush with finished concrete surface when no joint sealant is required.
 3. Furnish joint fillers in one-piece lengths for full width being placed wherever possible. Where more than one length is required, lace or slip joint filler sections together.
 4. Protect top edge of joint filler during concrete placement with a metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.
 5. Cure sealants in compliance with manufacturer's instructions and recommendations, to obtain high early bond strength, internal cohesive strength and surface durability. Protect sealants during construction period, so that they will be without deterioration or damage (other than normal wear and weathering) at time of Final Completion.
- E. Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt-coat one half of dowel length to prevent concrete bonding to one side of joint.

3.06 CONCRETE PLACEMENT

- A. Inspection: Before placing concrete, inspect and complete formwork installation, reinforcing steel, and items to be embedded or cast in. Notify other trades to permit installation of their work. Notify Owner's Representative minimum 24 hours prior to commencement of concreting operations.
- B. Do not place concrete until subbase and forms have been checked for line and grade. Moisten subbase if required to provide a uniform dampened condition at the time concrete is placed. Do not place concrete around manholes or other structures until they are at required finished elevation and alignment.
- C. Remove snow, ice, or frost from subbase surface and reinforcing before placing concrete. Do not place concrete on surfaces that are frozen.
- D. Moisten subbase to provide a uniform dampened condition at the time concrete is placed. Do not place concrete around manholes or other structures until they are at the required finish elevation and alignment.
- E. Comply with requirements and with ACI 304R for measuring, mixing, transporting, and placing concrete.
- F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.
1. When concrete placing is interrupted for more than 1/2 hour, place a construction joint.
- G. Place concrete using methods which prevent segregation of the mix. Consolidate concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures to consolidate concrete complying with ACI 309R. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand-spreading and consolidation. Consolidate with care to prevent dislocating reinforcing, dowels, and joint devices. Do not break or interrupt successive pours so that cold joints occur.

- H. Place concrete to required lines and grades shown on drawings. Grading between required lines and points where elevations are given to be smooth and uniform. Slope finish grades to drain surface water away from buildings unless otherwise shown on drawings. Variations from true plane for both horizontal and vertical surfaces of exposed concrete are not to exceed 1/8" in 10'-0".
- I. Screed paved surfaced with a straightedge and strike off. Use bull floats or darbies to form a smooth surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces prior to beginning finishing operations.
- J. No cement water or mortar shall be added to the surface during the finishing operation.
- K. Curbs and Gutters: When automatic machine placement is used for curb and gutter placement, submit revised mix design and laboratory test results that meet or exceed requirements. Produce curbs and gutters to required cross section, lines, grades, finish, and joining as specified for formed concrete. If results are not acceptable, remove and replace with formed concrete.
- L. Slip-Form Pavers: When automatic machine placement is used for paving, submit revised mix design and laboratory test results that meet or exceed requirements. Produce paving to required thickness, lines, grades, finish, and jointing as required for formed paving. Compact subbase and prepare subgrade of sufficient width to prevent displacement of paver machine during operations.
- M. When adjoining pavement lanes are placed in separate pours, do not operate equipment on concrete until pavement has attained 85 percent of its 28-day compressive strength.
- N. Cold-Weather Placement: Comply with provisions of ACI 306R and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
 - 1. When air temperature has fallen to or is expected to fall below 40°F (4°C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50°F (10°C) and not more than 80°F (27°C) at point of placement.
 - 2. Do not use frozen materials or materials containing ice or snow.
 - 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise accepted in mix designs.

3.07 CONCRETE FINISHING

- A. Float Finish: Begin floating when bleed water sheen has disappeared and the concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand-floating if area is small or inaccessible to power units. Finish surfaces to true places within a tolerance of 1/4 inch in 10 feet as determined by a 10 foot long straightedge placed anywhere on the surface in any direction. Cut down high spots and fill low spots. Refloat surface immediately to a uniform granular texture.
 - 1. Medium-to-Fine Textured Broom Finish: Draw a soft bristle broom across concrete surface perpendicular to line of traffic to provide a uniform fine line texture finish.
 - 2. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating surface 1/16 inch to 1/8 inch deep with a stiff-bristled broom, perpendicular to line of traffic.
- B. Final Tooling: Tool edges of paving, gutters, curbs, and joints formed in fresh concrete with a jointing tool to radius shown on drawings. Repeat tooling of edges and joints after applying surface finishes. Eliminate tool marks on concrete surfaces.

3.08 FINISHING VERTICAL SURFACES

A. Finishing Concealed Vertical Concrete Surfaces

1. Provide rough form finish, complying with ACI 301, Paragraph 10.2.1.
2. Remove fins and projections exceed $\frac{1}{4}$ inch in height and patch tie holes and surface defects.

B. Finishing Exposed Vertical Concrete Surfaces

1. Forms should be stripped and exposed surface finished the same day as the concrete is placed.
2. Provide smooth form finish complying with ACI 301, Paragraph 10.2.2.
3. Remove fins and projections and patch tie holes and surface defects.
4. Provide smooth rubbed finish for exposed curb and walk edges, complying with ACI 301, Paragraph 10.3.1.

3.09 SPECIAL FINISHES

- A. Integral Colored Concrete: Incorporate integral color admixture into concrete mix per manufacturer's requirements. Provide standard trowel edge with broom finish consistent with surrounding site sidewalk concrete areas.

3.10 CONCRETE PROTECTION AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with the recommendations of ACI 306R for cold weather protection and ACI 305R for hot weather protection during curing.
- B. Evaporation Control: In hot, dry, and windy weather, protect concrete from rapid moisture loss before and during finishing operations with an evaporation-control material. Apply according to manufacturer's instructions after screeding and bull floating, but before floating.
- C. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
- D. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these as follows:
1. Moisture Curing: Keep surfaces continuously moist for not less than 7 days with the following materials:
 - a. Water
 - b. Continuous water-fog spray
 - c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with a 12-inch lap over adjacent absorptive covers.
 2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
 3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's directions. Recoat areas subjected to heavy rainfall within 3 hours after initial application. Maintain continuity of coating and repair damage during curing

period.

3.11 JOINING NEW TO EXISTING CONCRETE

- A. Construct suitable connections between new and existing concrete where existing driveways, walks, and other structures are cut back to permit the new construction or where the new construction abuts the existing concrete. Unless shown or directed otherwise, furnish and place minimum 12 mm (1/2 inch) thick performed expansion joint filler between new and existing concrete.

3.12 FIELD QUALITY CONTROL TESTING

- A. Employ a qualified independent testing and inspection agency to sample materials, perform tests, and submit test reports during concrete placement as follows:
- B. The Owner will employ a qualified testing and inspection agency to sample materials, perform tests, and submit test reports during concrete placement. Sampling and testing for quality control may include the following:

1. Sampling Fresh Concrete: ASTM C 172, except modified for slump to comply with ASTM C 94.
 - a. Slump: ASTM C 143; one test at point of placement for each compressive-strength test but no less than one test for each day's pours of each type of concrete. Additional tests will be required when concrete consistency changes.
 - b. Air Content: ASTM C 231, pressure method; one test for each compressive-strength test but no less than one test for each day's pours of each type of air-entrained concrete.
 - c. Concrete Temperature: ASTM C 1064. One test hourly when air temperature is 40°F (4°C) and below and when 80°F (27°C) and above, and one test for each set of compressive-strength specimens.
 - d. Compression Test Specimens: ASTM C 31. One set of four standard cylinders for each compressive-strength test, unless directed otherwise. Mold and store cylinders for laboratory-cured test specimens except when field-cured test specimens are required.
 - e. Compressive-Strength Tests: ASTM C39. One set for each day's pour of each concrete class exceeding 5 sq. yd. but less than 25 cu. yd. plus one set for each additional 50 cu. yd. Test one specimen at 7 days, test two specimens at 28 days, and retain one specimen in reserve for later testing if required.
2. When frequency of testing will provide fewer than five strength tests for a given class of concrete, conduct testing from at least five randomly selected batches or from each batch if fewer than five are used.
3. When total quantity of a given class of concrete is less than 50 cu. yd. Engineer may waive strength testing if adequate evidence of satisfactory strength is provided.
4. When strength of field-cured cylinders is less than 85% of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete.
5. Strength level of concrete will be considered satisfactory if averages of sets of three consecutive strength test results equal or exceed specified compressive strength and no individual strength test result falls below specified compressive strength by more than 500 psi.

- C. Test results will be reported in writing to the Owners Representative, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive strength tests shall contain the

Project identification name and number, date of concrete placement, name of concrete testing agency, concrete type and class, location of concrete batch in paving, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7-day and 28-day tests.

- D. Additional Tests: The testing agency will make additional tests of the concrete when test results indicates lump, air entrainment, concrete strengths, or other requirements have not been met, as directed by the Owner's Representative. Testing agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed.

3.13 REPAIRS AND PROTECTION

- A. Remove and replace concrete paving that is broken, damaged, or defective, or does not meet the requirements of this section.
- B. Drill test cores where directed by the Owners Representative when necessary to determine magnitude of cracks or defective, or does not meet the requirements of this section.
- C. Protect concrete from damage. Exclude traffic from paving or at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.
- D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep concrete paving not more than 2 days prior to date scheduled for Substantial Completion inspections.
- E. Barricade area containing fresh concrete slabs, stairs, ramps, curbs, and walks for 24 hours minimum.
- F. Cover fresh concrete with 1/2-inch thick, plywood or oriented strand board for 48 hours minimum where exposed to public, pedestrian, and animal traffic.
- G. Protect concrete from shrinkage crack damage until protected by curing procedure.
- H. Protect concrete from physical damage or reduced strength caused by air temperatures below 45°F during curing period, as recommended in ACI 306R.
- I. Protect concrete from physical damage or reduced strength caused by air temperatures above 75°F during curing period, as recommended in ACI 305R.

3.14 REPAIRING EXPOSED VERTICAL CONCRETE SURFACES

- A. Clean, dampen, and brush-coat concrete patch areas with acrylic or epoxy bonding agents.
- B. Fill honeycomb voids and rock pockets with patching compound.
- C. Compact and screed patching compound in place as recommended by patching compound manufacturer.
- D. Finish exposed concrete patches to match adjacent surfaces.
- E. Strike off excess patching compound at exposed surface.
- F. If defects in color and texture of concrete surface cannot be repaired, remove and replace the defective concrete.

END OF SECTION

PART 1 GENERAL

1.1 DESCRIPTION

- A. Section Includes:
1. Construction of curbing
 2. Construction of gutters
 3. Construction of sidewalks
 4. Concrete driveways

1.2 REFERENCES

- A. California Department of Transportation Standard Specifications – Division VI, VII, & VIII. (2010 edition)
- B. ACI: American Concrete Institute
1. ACI 117 - Standard Specification for Tolerances for Concrete Construction Materials
 2. ACI 301 - Standard Specifications for Structural Concrete
 3. ACI 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete
 4. ACI 308 - Standard Practice for Curing Concrete
 5. ACI 318 - Building Code Requirements for Reinforced Concrete
- C. ASTM: American Society for Testing and Materials
1. ASTM A185 - Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
 2. ASTM A615 - Deformed and Plain Billet-Steel for Concrete Reinforcement
 3. ASTM C31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field
 4. ASTM C33 - Concrete Aggregates
 5. ASTM C143 - Standard Test Method for Slump of Hydraulic-Cement Concrete
 6. ASTM C150 - Portland Cement
 - ASTM C172 - Standard Practice for Sampling Freshly Mixed Concrete
 7. ASTM C260 - Specification for Air-Entraining Admixtures for Concrete
 8. ASTM C309 - Liquid Membrane-Forming Compounds for Curing Concrete
 9. ASTM D994 - Preformed Expansion Joint Filler for Concrete (Bituminous)
 10. ASTM D1190 - Concrete Joint Sealer, Hot Poured, Elastic Type
 11. ASTM D1751 - Performed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types)
 12. ASTM D2628 - Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements
- D. City of Eureka Engineering Standard Details:
1. R-12 Concrete Ribbon Gutter
 2. R-20 Concrete Curb & Sidewalk
 3. R-23 Detectable Warning Surface Installation
 4. R-30 Residential Driveway
 5. R-31 Commercial Driveway
 6. R-90 Curb Face Address Numbers

1.3 SUBMITTALS

- A. Product Data: Submit the respective manufacturer's product data for manufactured products.
- B. Shop Drawings:
1. Submit drawings that indicate the section profile of curb and gutter, and the locations of

joints in concrete, including construction joints, expansion joints, isolation joints, and contraction joints.

2. Submit drawings of extruded curbs and gutters, if proposed, and any modification of the indicated section profile required by the extrusion process.
3. Submit drawings of reinforcing steel, tie bars, and connecting dowels.

1.4 QUALITY ASSURANCE

- A. Perform Work according to California Department of Transportation standards.
- B. Perform Work according to American Concrete Institute standards.
- C. Perform Work to the City of Eureka Engineering Standard Details.
- D. Check surface areas at intervals necessary to eliminate ponding areas. Remove and replace unacceptable work as directed by the Engineer.

PART 2 PRODUCTS

2.1 FORMS

- A. Forms: Steel, wood, or other suitable material of size and strength to resist movement during concrete placement and to retain horizontal and vertical alignment until removal. Use straight forms, free of distortion and defects. Use flexible spring steel forms or laminated boards to form radius bends as required. Forms shall be of depth equal to depth of curbing or sidewalk, and so designed as to permit secure fastening together at tops. Coat forms with non-staining type of coating that will not discolor or deface surface of concrete.

2.2 REINFORCING

- A. Welded Wire Mesh: Welded plain cold-drawn steel wire fabric, ASTM A185. Furnish in flat sheets.
- B. Reinforcing Steel: Deformed steel bars, ASTM A615, Grade 60.
- C. Dowel Bars: Shall conform to ASTM A615, grade 60, and plain steel bars.

2.3 CONCRETE

- A. Portland Cement: Shall conform to ASTM C150, Type II.
- B. Aggregate: Shall conform to ASTM C33.
- C. Water: Shall be clean and potable.
- D. Air Entraining Mixture: Shall conform to ASTM C260.
- E. Curbing: Curbing shall conform to the requirements of City of Eureka Engineering Standard Details R-20, R-23, and R-90.
- F. Gutters: Gutters shall conform to the requirements of City of Eureka Engineering Standard Detail R-12.
- G. Driveways: Driveways shall conform to the requirements of City of Eureka Engineering

Standard Details R-31.

2.4 EXPANSION MATERIAL

- A. Joint Fillers: Resilient pre-molded bituminous impregnated fiberboard units complying with ASTM D994, D1751, D2628.

2.5 ADHESIVE EXTRUDED CURB

- A. Joint Sealants: Conforming to ASTM D1190, non-priming, pourable, self-leveling polyurethane.

2.6 CURING COMPOUND

- A. Curing Compound: Shall conform to ASTM C309.

PART 3 EXECUTION

3.1 PREPARATION

- A. Cast In Place Concrete: Compact subgrade to the requirements of Section 31 23 00, Trenching, Backfilling, and Compacting. Immediately prior to placing the concrete, wet the subgrade thoroughly to prevent moisture loss from the concrete mix to the subgrade.
- B. Extruded Concrete: Prior to placing curbing, clean the existing surface and apply bonding agent to the entire contact surface.

3.2 JOINTS

- A. Cast In Place Concrete: Construct contraction joints of the weakened plane type between expansion joints at intervals of no more than 10 feet unless otherwise shown on the drawings. Form the contraction joints by grooving and inserting a preformed bituminous filler, or by other approved means. The top width of the joints shall not be less than 1/8 inch or greater than 1/4 inch. The joints shall penetrate 2 inches into the face and top surface of the curb.
- B. Extruded Concrete: Construct saw joints every 20 feet.
- C. Driveways: Construct in accordance with the drawings.

3.3 PLACEMENT AND FINISHING

- A. The concrete forms, if of wood, shall be sprayed, oiled, or otherwise covered with an impermeable membrane before use.
- B. Remove forms after the concrete has taken its initial set and while the concrete is still green. Repair minor defects with mortar containing one part portland cement and two parts sand. Plastering will not be permitted on the faces and exposed surfaces. Honeycombed and other structurally defective concrete shall be removed and replaced at no added cost to the Owner. While the concrete is still green, the exposed surfaces shall be finished by rubbing down high spots and form marks, by rubbing the moistened surfaces with a suitable device to provide a uniform texture and smooth surface, or by applying and rubbing a thin cement grout to produce a uniform color.
- C. Broom-finish driveways with strokes at right angles to length. Smoothly finish edges with an

edging tool, and be free of broom marks.

- D. Cast in place curb top and the 10 inches of curb face shall be steel trowelled and “broom” finished with a fine haired broom parallel to the direction of the curb.
- E. After finishing has been completed, cover the concrete with an impermeable membrane, or keep continuously wet, until the concrete has reached a compressive strength of at least 2500 psi.
- F. Protect and cure surfaces from which forms are removed before the curing period has elapsed as specified for surfaces not covered by forms.

3.4 CURING AND PROTECTION DRIVEWAYS

- A. Apply curing compound to exposed surfaces immediately after finishing.
- B. Apply in sufficient quantity to obscure natural color of the concrete.

3.5 CONSTRUCTION ADJACENT TO CURB

- A. No base rock shall be placed above the bottom of the curb until the concrete has reached a compressive strength of at least 2500 psi. Curbs shall be properly backfilled before base aggregate is placed and compacted.
- B. After completion of the paving, repair chips and gouges in the exposed portion of the curb. For patching, use cement mortar containing one part portland cement and two parts sand.

3.6 TOLERANCES

- A. The finished surfaces shall be within 1/4 inch, plus or minus, of finish grade and alignment.
- B. Slab tolerances shall be “straightedge tolerance” as specified in ACI 117 and deviate not more than 1/8 inch from a 10-foot straightedge placed anywhere on the surface.
- C. The exposed surfaces shall be brush finished and free of spalls, holes, rock pockets or honeycomb and shall present a smooth, clean and neat appearance.
- D. All finished concrete surfaces to be in compliance with the accessibility requirements of the California Building Code and ADA work exceeding max. slope will result in replacement of work.

END OF SECTION

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Traffic lines and markings.
 2. Legends.
 3. Paint.
 4. Glass beads.

1.2 REFERENCES

- A. ASTM:
1. ASTM D34 - Standard Guide for Chemical Analysis of White Pigments
 2. ASTM D126 - Standard Test Methods for Analysis of Yellow, Orange, and Green Pigments Containing Lead Chromate and Chromium Oxide Green
 3. ASTM D562 - Standard Test Method for Consistency of Paints Measuring Krebs Unit (KU) Viscosity Using a Stormer-Type Viscometer
 4. ASTM D711 - Standard Test Method for No-Pick-Up Time of Traffic Paint
 5. ASTM D713 - Standard Practice for Conducting Road Service Tests on Fluid Traffic Marking Materials
 6. ASTM D969 - Standard Guide for Selection of Tests for Traffic Paints
 7. ASTM D1394 - Standard Test Methods for Chemical Analysis of White Titanium Pigments
 8. ASTM D1475 - Standard Test Method For Density of Liquid Coatings, Inks, and Related Products
 9. ASTM D2202 - Standard Test Method for Slump of Sealants
 10. ASTM D2371 - Standard Test Method for Pigment Content of Solvent-Reducible Paints
 11. ASTM D2621 - Standard Test Method for Infrared Identification of Vehicle Solids From Solvent-Reducible Paints
 12. ASTM D2743 - Standard Practices for Uniformity of Traffic Paint Vehicle Solids by Spectroscopy and Gas Chromatography
- B. AASHTO:
5. M247 - Standard Specification for Glass Beads Used in Pavement Markings.
- C. California Department of Transportation Standard Specifications – Division IX & X. (2010 edition)
- D. City of Eureka Engineering Standard Details:
1. R-40 Pavement Markings
 2. R-41 Pavement Striping
 3. R-43 Typical Crosswalk

1.3 SUBMITTALS

- A. Product Data: Paint formulation for each type of paint.
- B. Samples:
1. Eight sample plates of each color of material. Prepare four plates without glass beads and four with glass beads for each different batch of material. After approval, Owner will retain these plates for field comparisons of applied paint.
 2. Two gallons and four one-quart paint samples accompanied by properly executed test reports.

- 3. Glass bead in compliance with AASHTO M247.
- C. Manufacturer's Certificate: Products meet or exceed the specified requirements.
- D. Test and Evaluation Reports: Submit source and acceptance test results according to AASHTO M247.
- E. Manufacturer's Instructions: Application temperatures, eradication requirements, application rate, line thickness, type of glass beads, bead embedment and bead application rate, and any other data on proper installation.

1.4 QUALITY ASSURANCE

- A. Perform Work according to City of Eureka Engineering Standard Details and California Department of Transportation standard.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Invert containers several days prior to use when paint has been stored more than two months. Minimize exposure to air when transferring paint. Seal drums and tanks when not in use.
- B. Glass Beads. Store glass beads in cool, dry place. Protect from contamination by foreign substances.

1.6 AMBIENT CONDITIONS

- A. Do not apply materials when surface and ambient temperatures are outside temperature ranges required by paint product manufacturer.
- B. Do not apply exterior coatings during rain or snow when relative humidity is outside humidity ranges, or moisture content of surfaces exceed those required by paint product manufacturer.
- C. Do not apply paint when temperatures are expected to fall below 50 degrees F for 24 hours after application.
- D. Volatile Organic Content (VOC). Do not exceed State or U.S. EPA maximum VOC on traffic paint.

1.7 WARRANTY

- A. Furnish three year manufacturer's warranty for traffic paints.

PART 2 PRODUCTS

2.1 PAINTED PAVEMENT MARKINGS

- A. Furnish materials according to City of Eureka Engineering Standard Details and California Department of Transportation standards.
- B. Performance / Design Criteria:
 - 1. Paint Adhesion: Adhere to road surface forming smooth continuous film one minute after application.
 - 2. Paint Drying: Tack free by touch so as not to require coning or other traffic control

devices to prevent transfer by vehicle tires within ten minutes after application.

- C. Paint: Ready mixed, conventional and fast dry waterborne traffic paints, lead-free, non-toxic, AASHTO Test Deck, minimum retroreflectance of 100 mcds, durability rating of 6 or more after in place for nine months; within following limits:
 - 1. Pigment, percent by weight: 60 plus or minus 2.
 - 2. Vehicle, percent by weight: 40 plus or minus 2.
 - 3. Non-Volatile, percent by weight of paint: 76.0.
 - 4. Weight per gallon, pounds minimum 13.0.
 - 5. Viscosity: 80 to 95 Krebs Units at 77 degrees F.
 - 6. Grind (Hegeman Gauge), minimum Field Tested no tracking time under ambient conditions: 20 to 90 seconds.
 - 7. Dry-through Time, 15 mils wet at 90 percent relative humidity, 72 degrees F, ASTM D1640: 125 minutes maximum.
 - 8. VOC (Volatile Organic Content): 1 lb/gal maximum.
- D. Glass Beads: AASHTO M247, Type 1, coated to enhance embedment and adherence with paint.

2.2 EQUIPMENT

- A. Continuous Longitudinal Line Application Machine:
 - 1. Dual-nozzle paint gun to simultaneously apply parallel lines of indicated width in solid or broken patterns or various combinations of those patterns.
 - 2. Pressurized bead gun to automatically dispense glass beads onto painted surface, at required application rate.
 - 3. Measuring device to automatically and continuously measure length of each line placed, to nearest foot.
 - 4. Device to heat paint to manufacturers temperature recommendations for fast dry applications.
- B. Machine Calibration: Calibrate machines to meet specified tolerances.
- C. Other Equipment:
 - 1. For application of crosswalks, intersections, stop lines, legends and other miscellaneous items by walk behind strippers, hand spray or stencil trucks, apply with equipment meeting requirements of this Section. Do not use hand brushes or rollers. Optionally apply glass beads by hand.

2.3 SOURCE QUALITY CONTROL

- A. Test and analyze traffic paints according to ASTM D34, ASTM D126, ASTM D562, ASTM D711, ASTM D713, ASTM D969, ASTM D1394, ASTM D1475, ASTM D2202, ASTM D2371, ASTM D2621, and ASTM D2743.
- B. Allow witnessing of factory inspections and test at manufacturer's test facility. Notify Engineer at least seven days before inspections and tests are scheduled.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Do not apply paint to concrete surfaces until concrete has cured for 28 days.

3.2 PREPARATION

- A. Maintenance and Protection of Traffic:
 - 1. Prevent interference with marking operations and prevent traffic on newly applied markings before markings dry.
 - 2. Maintain travel lanes between 7 AM to 9 AM, and between 4 PM and 6 PM.
 - 3. Maintain access to existing businesses and other properties requiring access.

- B. Surface Preparation.
 - 1. Clean and dry paved surface prior to painting.
 - 2. Blow or sweep surface free of dirt, debris, oil, grease or gasoline.
 - 3. Spot location of final pavement markings as specified and as indicated by applying pavement spots 25 feet on center
 - 4. Notify Engineer after placing pavement spots and minimum three days prior to applying traffic lines.

3.3 DEMOLITION

- A. Remove existing markings in an acceptable manner. Do not remove existing pavement markings by painting over with blank paint. Remove by methods that will cause least damage to pavement structure or pavement surface. Satisfactorily repair any pavement or surface damage caused by removal methods.

- B. Clean and repair existing remaining or reinstalled lines and legends.

3.4 APPLICATION

- A. Agitate paint for 1 to 15 minutes prior to application to ensure even distribution of paint pigment.

- B. Dispense paint at ambient temperature to wet film thickness of 15 mils, except dispense edge markings to wet-film thickness of 12 mils.

- C. Apply glass beads at rate of 6 lb per gal of paint.

- D. Unless material is track free at end of paint application convoy, use traffic cones to protect markings from traffic until track free. When vehicle crosses a marking and tracks it or when splattering or over spray occurs, eradicate affected marking and resultant tracking and apply new markings.

- E. Install Work according to City of Eureka Engineering Standard Details and California Department of Transportation standards.

3.5 TOLERANCES

- A. Maximum Variation from Wet Film Thickness: 1 mil.

- B. Maximum Variation from Wet Paint Line Width: Plus or minus 1/8 inch.

- C. Maintain cycle length for skip lines at tolerance of plus or minus 6 inches per 40 feet and line length of plus or minus 3 inches per 10 feet.

- D. Maximum Variation from Specified Application Temperature: Plus or minus 5 degrees F

3.6 FIELD QUALITY CONTROL

- A. Inspect for incorrect location, insufficient thickness, line width, coverage, retention, uncured

or discolored material, and insufficient bonding.

- B. Repair lines and markings, which after application and curing do not meet following criteria:
 - 1. Incorrect Location: Remove and replace incorrectly placed patterns.
 - 2. Insufficient Thickness, Line Width, Paint Coverage, Glass Bead Coverage or Retention: Prepare defective material by acceptably grinding or blast cleaning to remove substantial amount of beads and to roughen marking surface. Remove loose particles and debris. Apply new markings on cleaned surface according to this Section.
 - 3. Uncured or Discolored Material, Insufficient Bonding: Remove defective markings according to this Section and clean pavement surface 1 foot beyond affected area. Apply new markings on cleaned surface according to this Section.
- C. Replace defective pavement markings as specified throughout warranted period. Replace markings damaged by anti-skid materials, studded tires, tire chains, chemical deicers, snow plowing or other loss of marking material regardless of cause. When markings are damaged by pavement failure or by Owner's painting, crack sealing, or pavement repair operations, Contractor is released from warranty requirements for damaged Work.
- D. Prepare list of defective areas and areas requiring additional inspection and evaluation to decide where material may need replaced. Provide traffic control as necessary if markings require more detailed evaluation.
- E. Replace failed or defective markings in entire section of defective markings within 30 days after notification when any of following exists during warranty period:
 - 6. Average retroreflectivity within any 528 foot section is less than 1 225 mcd/m²/1x for white pavement markings and 100 mcd/m²/1x for yellow pavement markings.
 - 7. Marking is discolored or exhibits pigment loss, and is determined to be unacceptable by Owner.
 - 8. More than 15 percent of area of continuous line, or more than 15 percent of combined area of skip lines, within any 528 foot section of roadway is missing.
- F. Replace pavement marking material under warranty using original or better type material. Continue warranty to end of original warranty period even when replacement materials have been installed as specified.
- G. When eradication of existing paint lines is necessary, eradicate by shot blast or water blast method. Do not gouge or groove pavement more than 1/16 inch during removal. Limit area of removal to area of marking plus 1 inch on all sides. Prevent damage to transverse and longitudinal joint sealers, and repair any damage according to requirements in Section 32 13 13 or Section 32 12 16.
- H. Maintain daily log showing Work completed, results of above inspections or tests, pavement and air temperatures, relative humidity, presence of any moisture on pavement, and any material or equipment problems. Make legible entries in log in ink, sign and submit by end of each working day. Enter environmental data into log prior to starting Work each day and at two additional times during day.

3.7 PROTECTION

- A. Protect painted pavement markings from vehicular and pedestrian traffic until paint is dry and track-free. Follow manufacturer's recommendations or use minimum of 30 minutes. Consider barrier cones as satisfactory protection for materials requiring more than two minutes dry time.

3.8 MAINTENANCE

- A. Furnish service and maintenance of traffic paints for three years from date of Substantial Completion.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Embedded tactile warning surface tile, with an inline dome pattern, for application on ramps and level walking surfaces.
- B. Tactile Tile Installation Method: As indicated on Drawings, and as follows:
 - 1. New Concrete: Installation in cast-in-place uncured (wet) concrete.

1.2 RELATED SECTIONS

- A. Section 03 30 00 – Cast-In-Place Concrete.

1.3 REFERENCES

- A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only. Refer to Section 01 42 00 “References” for definitions, acronyms, and abbreviations.
- B. Referenced Standards:
 - 1. AASHTO HB-17 – Standard Specifications for Highway Bridges.
 - 2. ASTM B117 – Standard Practice for Operating Salt Spray (Fog) Apparatus.
 - 3. ASTM C293 – Standard Test Method for Flexural Strength of Concrete (Using Simple Beam With Center-Point Loading).
 - 4. ASTM C1028 – Standard Test Method for Determining the Static Coefficient of Friction of Ceramic Tile and Other Like Surfaces by the Horizontal Dynamometer Pull-Meter Method.
 - 5. ASTM D543 – Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents.
 - 6. ASTM D570 – Standard Test Method for Water Absorption of Plastics.
 - 7. ASTM D638 – Standard Test Method for Tensile Properties of Plastics.
 - 8. ASTM D695 – Standard Test Method for Compressive Properties of Rigid Plastics.
 - 9. ASTM D1037 – Standard Test Methods for Evaluating Properties of Wood-Base Fiber and Particle Panel Materials.
 - 10. ASTM D2486 – Standard Test Methods for Scrub Resistance of Wall Paints.
 - 11. ASTM D5420 – Standard Test Method for Impact Resistance of Flat, Rigid Plastic Specimen by Means of a Striker Impacted by a Falling Weight (Gardner Impact).
 - 12. ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials.
 - 13. ASTM G155 – Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials.

1.4 SUBMITTALS

- A. Submit under provisions of Section 01 33 00 “Submittal Procedures”.
- B. Shop Drawings: Show detailed plans of tile profile, fastener locations, and installation methods.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Firm specializing in manufacturing products specified in this Section with a minimum 5 years experience.

1.6 REGULATORY REQUIREMENTS

- A. General: Provide detectable (tactile) warning products in accordance with CCR. Title 24, Part 1, 2010 California Administrative Code, Chapter 5 "Access to Public Buildings by Persons with Disabilities."
 - 1. Article 3 "Acceptance of Detectable Warning and Directional Surface Products for Manufacturers and Design Professionals."
 - 2. Article 4 "Application for Independent Entity Evaluation Approval (IEEA)."
- B. Definition of Detectable Warning: Conform to 2010 California Building Code, Chapter 2 "Definitions," Section 202 "Definitions."
 - 1. Chapter 11B "Accessibility to Public Buildings, Public Accommodations, Commercial Buildings and Publicly Funded Housing," Section 1102B "Definitions" for detectable warning.
- C. Detectable Warnings for Site Accessibility: Provide detectable warning system in accordance with 2010 California Building Code, Chapter 11B, "Accessibility to Public Buildings, Public Accommodations, Commercial Buildings and Publicly Funded Housing," and ADAAG as applicable.
 - 1. Detectable Warnings at Curb Ramps: Chapter 11B, Section 1127B "Exterior Routes of Travel," Article 1127B.5.7 "Detectable Warnings."
 - 2. Detectable Warnings at Hazardous Vehicular Areas: Chapter 11B, Section 1133B "General Accessibility for Entrances, Exits and Paths of Travel," Article 1133B.8.5 "Detectable Warnings at Hazardous Vehicular Areas."

1.7 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store and handle packaged products in original containers with seals unbroken and labels intact until the time of installation.
- B. Store delivered products in a clean, safe, dry area.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of Design Product: Armor-tile by Engineered Plastics Inc., Williamsville, NY; 800-682-2525, <http://www.armor-tile.com>.
 - 1. Provide Cast-In-Place Type Armor-Tile for embedding in cast-in-place uncured (wet) concrete.
 - 2. ADA Solutions, Inc., Cast-in-Place type.
 - 3. Or accepted equal
- B. Substitutions: Under provisions of Section 01 60 00, "Product Requirements".

2.2 MATERIALS

- A. Tactile Warning Tiles: An epoxy polymer composite with an ultraviolet stabilized coating containing aluminum oxide particles in the truncated domes.
 - 1. Cast-In-Place Type Tile for Embedding in Cast-In-Place Uncured (Wet) Concrete:
 - a. Tile thickness to be 0.3875 inch at domes and 0.1875 inch in flat areas between domes. Total thickness at perimeter to be 1.375 inches; dome height to be 0.20 inch.
 - b. Tile underside to have embedment flanges with 0.625-inch diameter holes; long sides to have 0.1875-inch diameter vent holes.

- c. Tile to have sound amplifying plastic plates attached between flanges, with an air space between tile bottom surface and sound amplifying plastic plates.
 - d. Tile face to have non-slip texture.
- B. Color and Size:
- 1. Safety Yellow, (Federal Color #33538) colorfast, UV stabilized coating. Color shall be uniform throughout the tile.
 - 2. Sizes: As indicated on Drawings.
- C. Performance Requirements: Tactile warning tiles shall meet or exceed the following criteria:
- 1. Water Absorption: 0.05 percent, maximum, when tested in accordance with ASTM D570.
 - 2. Slip Resistance: 0.80, minimum combined wet/dry static coefficient of friction on top of domes and field area, when tested in accordance with ASTM C1028.
 - 3. Compressive Strength: 28,000 psi, minimum, when tested in accordance with ASTM D695.
 - 4. Tensile Strength: 19,000 psi, minimum, when tested in accordance with ASTM D638.
 - 5. Flexural Strength: 25,000 psi, minimum, when tested in accordance with ASTM C293.
 - 6. Gardner Impact: 550 inch-pounds per inch minimum, when tested in accordance with ASTM D5420.
 - 7. Chemical Stain Resistance: No discoloration or staining when exposed to 10 percent hydrochloric acid, urine, saturated calcium chloride, black stamp pad ink, chewing gum, red aerosol paint, 10 percent ammonium hydroxide, 1 percent soap solution, turpentine, 5 percent Urea, diesel fuel, motor oil, and tested in accordance with ASTM D543.
 - 8. Wear Depth: 0.06 inch, maximum, after 1000 abrasion cycles of 40 grit Norton Metallite sandpaper, tested in accordance with ASTM D2486.
 - 9. Flame Spread: 15 maximum, when tested in accordance with ASTM E84.
 - 10. Accelerated Weathering: No deterioration, fading or chalking, when tested for 3,000 hours in accordance with ASTM G155.
 - 11. Accelerated Aging and Freeze Thaw Test of Tile and Adhesive System: No cracking, delamination, warping, checking, blistering, color change, loosening of tiles, or other detrimental defects, when tested in accordance with ASTM D1037.
 - 12. Salt and Spray Performance: No evidence of deterioration or defects after 200 hours of exposure, when tested in accordance with ASTM B117.
 - 13. AASHTO HB-17 Single Wheel HS20-44 Loading Test for Cast-In-Place Type Tile: Mounted on concrete platform with 1/2 inch air space at the underside of tile and subjected to a maximum load of 10,400 pounds, corresponding to 8000 pound individual wheel load and 30 percent impact factor; no visible damage at maximum loading.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install tactile warning surface tiles in accordance with manufacturer's printed instructions.
- B. Install Cast-In-Place Type tiles over cast-in-place, uncured (wet) concrete.
- C. Ensure that the surfaces being prepared and fabricated to receive the tiles are constructed correctly and adequately for tile installation.
- D. Installation in Cast-In-Place Uncured (Wet) Concrete: Maintain concrete in 4 inch to 7 inch slump range. Lay tactile warning surface tiles (without removing protective plastic wrap) in uncured (wet) concrete and tamp each tile in place. Place weights over tiles to prevent floating, as recommended by the manufacturer. After curing, remove protective plastic wrap, and clean tile surfaces.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Decorative metal picket fencing and accessories.
- B. Decorative metal picket gates and accessories.

1.2 REFERENCES

- A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only. Refer to Section 01 42 00 "References" for definitions, acronyms, and abbreviations.
- B. Unless otherwise noted, standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes as of the date of issue of this Project Manual.
- C. Referenced Standards:
 - 1. ASTM A47/A47M –Standard Specification for Ferritic Malleable Iron Castings.
 - 2. ASTM A500 – Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
 - 3. ASTM A513 – Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing.
 - 4. ASTM A653/A653M –Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - 5. ASTM B117 – Standard Practice for Operating Salt Spray (fog) Testing Apparatus.
 - 6. ASTM B695 – Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel.

1.3 SUBMITTALS

- A. Shop Drawings: Layout of fences with dimensions, details and finishes of components, accessories and post foundations.
- B. Product Data: Manufacturer's catalog cuts indicating material compliance and specified options.
- C. Samples: Color selections for finishes and samples of materials (e.g., caps and accessories).

1.4 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Sufficient experience manufacturing similar products.
- B. Erector's Qualifications: Sufficient experience installing similar products; approved by fence manufacturer.

1.5 PROTECTION

- A. Damage to Adjoining Property and Existing Surfaces: Contractor shall assume all responsibility for damage to building surfaces and materials and shall restore them to their original condition should damage occur.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store and handle materials so as to avoid damage.

PART 2 PRODUCTS

2.1 MANUFACTURER

- A. Ameristar, Product: Ornamental Picket Fence: Aegis II Industrial Weight, Classic Style C3 (3 rail).
- B. Monumental Iron Works.
- C. Or accepted equal.

2.2 ORNAMENTAL PICKET FENCE

- A. Materials for fence framework (i.e., pickets, rails and posts) shall be manufactured from coil steel having a minimum yield strength of 45,000 psi. All steel shall be galvanized to meet the requirements of ASTM A653/A653M with a minimum zinc coating weight of 0.90 ounces per square foot (coating designation G-90), hot dip process.
- B. Pickets: Material for fence pickets shall be 1" square x 14 gauge galvanized steel tubing with spear-pointed tops.
- C. Rails: The cross-sectional shape of the rails shall conform to the manufacturer's standard design, with outside cross section dimensions of 1.75" square and a minimum thickness of 14 gauge. Picket holes in rail shall be spaced 4.98" on center.
- D. Posts: Posts at fence shall be 3" square tube x 12 gauge, posts at gates up to 4'-0" wide shall be 4" square tube x 11 gauge, posts at gates over 4' wide shall be 8" x 8" x 1/4" HSS.
- E. Preassemble panels with rods or rivets supplied by manufacturer.
- F. Gates shall be fabricated using 1.75" x 14 ga. Double channel rail, 2" sq. x 11 ga. gate ends and 1" x 14 ga. pickets. Gates that exceed shall have a 1.75" x 14 ga. intermediate upright. All rail and upright intersections shall be a welded connection.
- G. Finish: Galvanized framework shall be subject to six stage pretreatment/wash (with zinc phosphate) followed by an electrostatic spray application of a two coat powder system. The base coat is a thermosetting epoxy powder coating (gray in color) with a minimum thickness of 2-4 mils. Top coat shall be a TGIC polyester powder coat finish with a minimum thickness of 2-4 mils. The color shall be black. Coated galvanized framework shall have a salt spray resistance of 3500 hours using ASTM B117 without loss of adhesion.

2.3 ACCESSORIES

- A. Ornamental Picket Fence Accessories: Provide indicated items required to complete fence system. Galvanize each ferrous metal item in accordance with ASTM B695 and finished to match framing.
- B. Rail Attachment Brackets: Pressed steel or cast malleable iron.
- C. Post Caps: Formed steel, cast or malleable iron, weathertight closure cap. Provide one standard post cap at each post.

- D. Privacy Panel: 22 gauge galvanized sheet steel, prefinished to match fence. Locations as shown on drawings.

2.4 POST SETTING MATERIALS

- A. Concrete: Minimum 28 day compressive strength of 3,000 psi.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify areas to receive fencing are completed to final guides and evaluations.
- B. Ensure property lines and legal boundaries of work are clearly established.

3.2 ORNAMENTAL PICKET FENCE INSTALLATION

- A. Verify location of all underground utilities prior to excavation for posts.
- B. Install fence in accordance with manufacturer's instructions.
- C. Space posts uniformly , 8'-0" on center max., unless otherwise noted.
- D. Concrete Footings: Drill holes in firm, undisturbed or compacted soil. Holes shall have diameter four times greater than outside dimension of posts and depths approximately 6" deeper than post bottom. Excavate deeper as required for adequate support in soft and loose soils and for posts with heavy lateral loads. Set post bottom below surface when in firm, undisturbed soil. Place concrete around posts in a continuous pour. Trowel finish around post and slope to direct water away from posts. Refer to Drawings for footing size.
- E. Check each post for vertical and top alignment and maintain in position during placement and finishing operations.
- F. Align fence panel posts. Panels shall be attached to posts using mechanically fastened panel brackets supplied by the manufacturer.
- G. Install post caps and other accessories to complete fence.

3.3 CLEANING

- A. Clean up debris and unused material and remove from the site.
- B. Touch up all scratches with paint to match specified finish.

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope of Work: The Contractor shall furnish all labor, materials, tools, equipment, and transportation required to perform and complete the installation of an automatic sprinkler irrigation system, including all piping, sprinkler heads, controls, connections, testing, etc. as shown on the Drawings and as specified herein.
- B. Related work in other sections: The following items of associated work are included in other sections of these specifications:
 - 1. Section 32 90 00, Planting.

1.2 QUALITY CONTROL

- A. Reviews: Contractor shall specifically request the following reviews prior to progressing with the work. Requests for reviews must be received in writing at least 48 hours in advance.
 - 1. Pressure testing and trench depths
 - 2. Operation of system and coverage adjustment of all heads
 - 3. Final inspection (End of maintenance).
- B. Regulatory Requirements: Work and materials shall be in accordance with latest rules, regulations, and other applicable State and local laws. Nothing in Construction Documents is to be construed to permit work not conforming to these codes.

1.3 PROTECTION

- A. Contractor shall be responsible for protection of existing irrigation and utilities within and immediately adjacent to the construction area; and repair, to the satisfaction of the Owner, any damages to irrigation and utility lines that occur as a result of operations of this work.
- B. Provide water and controls to existing adjacent irrigation system continuously through project as shown on the Drawings.
- C. Irrigate existing plant material continuously through the project as needed.
- D. Provide and install adequate warnings and barriers to prevent damage or injuries from irrigation operations and equipment.

1.4 SUBMITTALS

- A. Contractor shall submit manufacturer's cut sheets for each element of irrigation system before beginning work.
- B. On request, Contractor shall provide Owner with particle size sieve analysis of bedding sand and aggregate base showing compliance with specifications.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Rock-free Soil: Native or import soil free of rocks, roots, sticks, clods, debris, and other foreign matter over 1 inch in longest dimension.
- B. Bedding Sand: Course, clean sand meeting the following specifications.

Sieve Size	Percent Passing
#4	75-100
#50	0-70
#100	0-30
#200	0-15
- C. Pea Gravel: Clean, washed, natural stone with maximum particle size of ½ inch.
- D. Aggregate Base: Caltrans Standard Specifications, Section 26, Class 2 Aggregate Base

2.2 COMPONENTS

- A. The components will be as specified: All materials shall be new. Any deviation from the specifications must first be approved by the Owner in writing. All materials shall be clearly marked by manufacturer on all material containers or certificates of contents for inspection.
- B. Automatic Controller, Accessories, and Wire:
 - 1. Controller: As indicated on the Drawings.
 - 2. Direct Burial Wire:
 - a. Wire: Type UF, 14g insulated single strand copper, copper to meet ASTM B-3 requirements, common to be white.
 - b. Waterproof wire connectors: (3M DBY or DBR or approved equal).
 - 3. Weather Sensor: As indicated on the Drawings. Includes receiver, sensor, and interface equipment. Verify compatibility between rain sensor and controller.
- C. Pipe and Fittings:
 - 1. PVC pipe: Schedule 40 PVC with solvent weld joints, Type 1, Grade 1 PVC compound (ASTM D1784, ASTM D1785, ASTM D2672).
 - 2. PVC fittings: High impact, standard weight, Schedule 40, molded PVC (ASTM D2466), as manufactured by Spears, Lasco, or approved equal.
 - 3. Copper pipe and fittings shall be Type K per ASTM B-88.
 - 4. Brass pipe and nipples shall be red brass per ASTM B-687-88.
 - 5. Bronze fittings per ASTM B-62-93 and ASTM B-584.
- D. Electric Valves: 200 PSI rating, as indicated on the Drawings.

- E. Sprinkler Heads: As indicated on the Drawings.
- F. Quick Coupler Valves and Keys: brass, 125 psi, as indicated on the Drawings; provide 2 keys with matching hose swivels.
- G. Sleeves: SCH 40 PVC pipe with solvent weld joints.
- H. Ball Valves: SCH 80 PVC with unions (235 psi), SCH 40 PVC (150 psi).
- I. Valve Boxes: HDPE body with matching bolt-down cover; size box to facilitate equipment; minimum inside dimension-14"x19"; manufacturer: NDS, Brooks-Carson, or equal.
- J. Backflow Device and Enclosure: as indicated on the Drawings.
 - 1. As indicated on the Drawings.
 - 2. Insulating blanket: UV and fire retardent polyvinyl with polyfill insulation, brass grommets.
- K. Drip Irrigation:
 - 1. Plug-in drip emitters shall be pressure compensating, self-piercing, as indicated on the Drawings.
 - 2. Drip tubing shall be 5/8" (.700" OD) Union Carbide #7510 linear, low-density polyethylene resin with minimum 2% carbon black for UV protection. Fittings shall be compression fit and sized to fit tubing.
 - 3. Pressure regulating filter: 150 psi rating; 200 mesh; 30 or 40 psi outlet pressure; as indicated on the Drawings.
 - 4. Line flushing valve: as indicated on the Drawings.
 - 5. Staples: 6" long, 11g galvanized steel wire formed into "U" shape.

PART 3 - EXECUTION

3.1 EXISTING SITE CONDITIONS

- A. Locations of existing utilities and other improvements shown on the Drawings are approximate. Existing conditions shall be verified. Should any utilities be encountered that are not indicated on the plans, the Owner shall be notified immediately. The Contractor shall be held responsible for any damages caused to existing services.
- B. Existing irrigation components are the property of the Owner. Unless instructed otherwise, all removed irrigation components shall be given to the Owner.

3.2 GRADING

- A. Contractor shall be responsible for installing all irrigation features to their finished grade and at depths indicated. All rough grading and/or finish grading shall be completed and/or accommodated before trenching commences.

3.3 LAYOUT

- A. Contractor shall not make any changes from the original Drawings without receiving written permission from the Owner's Representative. All changes must be recorded on the record "As-built" drawings prepared by the Contractor.
- B. Location of pipe and valves on the Drawings is diagrammatic. Locate pipe and components in landscaped areas and valves near edge of turf, walks, or curbs as much as possible.

3.4 TRENCHING

- A. All trenches shall be open vertical construction, sufficiently wide to provide ample working space and depths as specified. PVC pipe may be made up on the surface and then placed in the trench. Do not cut existing tree roots measuring over 2 inches in diameter in order to install sprinkler lines. Where small roots must be cut, excavate around by hand and make clean cuts using a saw or ax.
- B. Minimum depth of cover:
 - 1. Mainlines: 18"
 - 2. Laterals: 12"
 - 3. Sleeves: 24" (18" if located above other utilities)

3.5 BACKFILLING

- A. All work must be inspected and approved by the Owner prior to covering. Give Owner a minimum of 48 hours written notice prior to filling trenches. All debris and rocks shall be removed from the trenches. Pipe shall have a firm uniform bearing for the entire length of each pipe line to prevent uneven settlement. Wedging or blocking of pipe will not be permitted.
- B. Backfill Material:
 - 1. Mainline: bedding sand around pipe (minimum 2" below, 4" above); remainder to be rock free soil.
 - 2. Laterals: Rock-free soil.
 - 3. Conduit and sleeves under paved areas: minimum 3" of bedding sand around pipe remainder to be aggregate base.
- C. Backfill shall be brought to uniform and optimum moisture content and mechanically compacted in 6" layers, to the following densities per ASTM D1557.
 - 1. Within landscape areas: 85% - 90%.
 - 2. Under pavement: 95%.

3.6 INSTALLATION

- A. Piping System:
 - 1. Handling of PVC pipe and fittings: The Contractor is cautioned to exercise care

in handling, loading, unloading, and storing PVC pipe; beds on which materials are stored must be full length of pipe to avoid damage. PVC pipe and fittings shall be especially protected from direct sunlight. Any section of pipe that has been dented or damaged shall not be used in the work.

- B. Laying of PVC pipe:
1. Install PVC pipe per manufacturers' recommendations and ASTM F1668 and as detailed on the Drawings. Handling and assembly of pipe, fittings, and equipment shall be accomplished by skilled tradesmen. Bending of pipe will not be permitted.
 2. Trenches shall be padded with bedding sand or rock-free soil as noted above. Pipe shall have a minimum cover of bedding sand or rock-free soil as noted above.
 3. PVC pipe should never be laid when there is water in the trench; or when the temperature is 32 degrees F or below.
 4. Snake pipe from side to side of trench bottom to allow for expansion and contraction.
 5. All foreign matter or dirt shall be removed from inside the pipe before joining and piping shall be kept clean by approved means during and after laying of pipe.
 6. Flushing: Remove end heads and operate system at full pressure until all debris, dirt, and sand is removed. Divert water to prevent ponding or damage to finished work.
- C. Thread Connections: A non-hardening pipe sealant (Weld-On "All Seal", Spears Blue 75, or approved equivalent) or Teflon tape shall be used on all threaded joints except at sprinklers.
- D. Provide PVC sleeves for water lines and wires under walks and paving. Backfill per Section 3.05. Cap or plug ends to prevent intrusion of backfill and debris.
- E. Solvent Weld Joints: Solvent weld joints shall be made with manufacturer's recommended solvent, applied in accordance with manufacturer's recommendations. Pipe and fitting shall be thoroughly cleaned of dirt, dust and moisture before applying solvent with a non-synthetic brush. Use primer, on pressure pipe only, prior to applying solvent.
- F. Sprinklers and Valves:
1. Sprinkler heads, shut off valves, electric valves, and quick coupler valves shall be located as shown on the Drawings except where existing conditions prohibit, or slight changes are approved to achieve as good or better coverage under the same conditions.
 2. Valves shall be located in planter areas and adjacent to walks, curbs, or turf areas. Install one valve per valve box.
 3. Install sprinkler heads and valves as detailed on the Drawings.
- G. Controls

1. Install control wires along-side the mainline wherever possible. Maintain a 3" separation. Install a loop every 100'.
 2. Run one extra common wire through all valve locations as backup; color to be different than other wires.
 3. Make all wire splices in valve boxes using specified connectors.
 4. Install controller as indicated on the Drawings. Provide control modules as needed.
 5. Install all sensors per Drawings and manufacturer's instructions. Make all interface connections. Program devices and controller for proper operation.
- H. Drip Tubing:
1. Install drip tubing on grade as shown on the Drawings after planting and finish grading have been completed. Secure with staples installed at 3' on center.
 2. Install flushing valves as shown on the Drawings or as requested by Owner.
 3. Cover drip tubing with specified top dressing after installation and testing.

3.7 FIELD QUALITY CONTROL

- A. Visual Inspection: Pipe shall be homogenous throughout and free from visual cracks, holes, or foreign materials. Inspection shall be made on each length of pipe. All materials are subject to impact test at the discretion of the Owner's Representative.
- B. Hydrostatic Tests - Open Trench:
1. Hydrostatic testing shall be conducted in accordance with the pipe manufacturer's recommended testing procedures.
 2. Request the presence of the Owner's Representative in writing at least 48 hours in advance of testing.
 3. Testing to be accomplished at the expense of the Contractor and in the presence of the Owner's Representative.
 4. Apply continuous static water pressure of 100 psi when welded plastic joints have cured at least 24 hours. Pipe shall be free of air at time of testing. With the risers and openings capped:
 - a. Main lines and submains to be tested for four hours.
 - b. Lateral lines to be tested for one hour.
 5. Drip tubing shall be brought to full working pressure and tested for 10 minutes.
 6. Repair leaks resulting from tests and repeat tests.
 7. Center load piping with a small amount of backfill to prevent arching or slipping under pressure.

- C. Backflow Testing: All new backflow devices shall be tested immediately after installation by a Certified Backflow Assembly Tester. A written copy of the test results shall be provided to the Owner.
- D. Test to determine that irrigation system functions according to manufacturer's data and gives full coverage according to intent of the Drawings. If not functioning as specified, correct system to provide satisfactory performance.

3.8 CLEAN UP

- A. Immediately clean up any soil, sand, or debris spilled onto streets, parking areas, and sidewalks and properly dispose legally off site. Sweep and/or wash all dirt and mud off paved areas.
- B. During all phases of the construction work, the Contractor shall take precautions to abate dust nuisance by cleanup, sweeping, sprinkling with water, or other means as necessary.

3.9 GUARANTEE

- A. All workmanship and materials hereunder shall be guaranteed for one year, from date of final acceptance, against defective workmanship and materials. This includes filling and repairing depressions and replacing plantings due to settlement of irrigation trenches. The Contractor is not responsible for vandalism or theft after date of final acceptance.

3.10 RECORD DRAWINGS

- A. Contractor shall regularly update plans of the systems and any changes made to the system throughout the project. Underground installations shall be indicated with at least two measurements from surface features such as walks and buildings. All changes shall be recorded on this plan before trenches are backfilled. The record drawing shall be made by the Contractor, completed and submitted to the Owner before payment shall be made for work installed.

3.11 CLOSE OUT

- A. One complete set of manufacturer's warranties, guarantees, instruction sheets, parts lists and operational manuals shall be delivered to the Owner before acceptance of the contract. Final inspection shall not be made until the sets are approved.
- B. Contractor shall program the irrigation controller and accessories and instruct the Owner's maintenance personnel in its operation.
- C. Contractor shall meet with the Owner's maintenance personnel to review the irrigation system and operation. Contractor shall provide the Owner with any equipment needed to adjust or operate the irrigation system.

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope of Work: The Contractor shall furnish all labor, materials, tools, equipment, and transportation required to perform and complete the following work as specified herein:
 - 1. Soil Placement, Preparation, and Fertilization
 - 2. Finish Grading
 - 3. Planting
 - 4. Weed Control and Top Dressing
 - 5. Maintenance and Guarantee Periods
- B. Related work in other Sections: The following items of associated work are included in other sections of these specifications:
 - 1. Section 32 80 00, Irrigation Systems.

1.2 QUALITY CONTROL

- A. Reviews: Contractor shall specifically request the following reviews in writing prior to progressing with the work. Contractor shall give Owner 48 hour notice prior to review.
 - 1. Soil placement, cultivation, and amending.
 - 2. Substantial completion.
 - 3. Acceptance of Completion (Begin Maintenance Period).
 - 4. Final Acceptance (End of Maintenance Period).
- B. Testing: As requested by Owner, import fill shall be tested by a licensed laboratory for soil fertility. Test shall include pH, organic matter, soil texture, salinity, infiltration rate, Nitrate, Phosphorus, Potassium, Calcium, Magnesium, Boron, Sodium, Sulfate, Iron, Sodium Absorption Ratio, and Cation Exchange Capacity. Test report shall include recommendations to address soil deficiencies. A copy of the soil fertility report shall be provided to the Owner and Architect. Contractor shall be responsible for cost of testing.

1.3 PROTECTION

- A. Contractor shall be responsible for the protection of all existing utilities within the construction area and shall repair any damage to these utility lines that might occur as a result of his operations to the satisfaction of the Owner's Representative.
- B. Provide adequate means for protection from damage through excessive erosion, flooding, and heavy rains. Repair or replace damaged areas.
- C. Protect trunks and roots of existing plants on site. Do not use heavy equipment within branch spread. Do not rip or rototill in areas with heavy root system.
- D. Keep all chemical amendments dry until after application.

- E. Provide and install adequate warnings and barriers to prevent damage or injuries from planting operations and equipment.
- F. Protect mycorrhizal inoculum from moisture, direct sunlight, and temperatures over 90°.

1.4 SUBMITTALS

- A. Samples of soil amendment, imported planter fill, and bark and gravel top dressing.
- B. Delivery slips indicating amount of soil amendment and fertilizer delivered to project site.
- C. Certificate of compliance for filter fabric.
- D. Soil fertility report (if requested by Owner).

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Materials to be used shall be in new and perfect condition. Materials shall be as specified; any deviation or substitution from the Drawings must first be approved by the Owner's Representative in writing.
- B. All chemicals shall conform to the requirements of the California Food and Agricultural Code and the County Agricultural Commissioner.
- C. Fertilizer/Soil Conditioner: 5-3-1 with 15% humic acid and soil penetrant (GroPower Plus or equal)
- D. Pre-plant Fertilizer: 6-24-24 with 5% sulfur, .75% zinc, and 1.5% iron (Best or equal)
- E. 21-0-0 with 24% Sulfur (Simplot Ammonium Sulfate or equal).
- F. Fertilizer Packs for Trees and Shrubs: Biodegradable fertilizer packets, 20-10-5 (Best, GroPower, RTI, or equal).
- G. Soil amendment: bark product, 90% bark base, 1/8" – 1/4" particle size, free of weeds, soil, toxic chemicals, and other debris.
- H. Mycorrhizal Inoculum
 1. 120 propagules of arbuscular mycorrhizae fungi per cubic centimeter in a solid carrier suitable for hydro-seeding or dry seeding equipment.
 2. RTI "AM 120" or approved equal.
- I. Plant Materials: Shall consist of all trees and shrubs listed on the Drawings. All plants shall conform to the requirements of the American Standard for Nursery Stock (ANSI Z60.1-2014). Plants shall be healthy, shapely, well rooted, not pot bound, free from insect pests or plant diseases, and properly hardened off before planting. Plants not alive and in satisfactory growing condition, as determined by Owner's Representative, shall be replaced without cost to Owner. All plants shall be true to name. The Owner's Representative may reject plants before or after planting. All plants of named variety shall be delivered with a nursery name tag attached. Minimum plant sizes:
Large tree - 15 gallon: 7' high.

Small tree – 15 gallon: 5' high.
Shrub – 5 gallon: 12" high x 12" wide.
Shrub – 1 gallon: 6" high or 6" wide.

- J. Import planter fill: fertile, loose, friable sandy loam, capable of sustaining vigorous plant growth. Fill shall be clean and free from toxic minerals and chemicals, noxious weeds, rocks larger than 1" in any dimension, and other objectionable materials. Acidity/alkalinity range: 5.5 to 7.0. Site soil may be used if it meets specifications.
- K. Bark Mulch Top Dressing: Untreated, redwood, fir, or cedar shredded bark. Maximum particle size: 1/2"x3". "Walk on Bark" or equal.
- L. Pre-emergent Weed Control: Treflan, Eptam, Surflan, Ronstar or approved equivalent.
- M. Gravel: 3/4" clean, crushed river stone or granite, free of soil, clay, and organic matter.
- N. Filter Fabric: Geotextile filter fabric: Caltrans Standard Specifications, Section 88-1.03.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Planting areas:
 - 1. Remove all aggregate base and debris from planters.
 - 2. Remove all debris and weeds and properly dispose.
- B. Inspect soil and weather conditions prior to planting. Planting over excessively wet, muddy or frozen soil or during freezing temperatures is not acceptable.
- C. Verify completion of soil preparation, irrigation system, and finish grading prior to planting.

3.2 SOIL PREPARATION

- A. Existing material in all planting areas shall be removed to a depth of 12" below finish grade. Dispose material off site. Loosen subsoil to a 4" depth prior to placing fill. Subsoil shall be free of paving, aggregate base, and debris. Soil preparation is for all planted areas.
- B. Place import planter fill in planters at depths as shown on Drawings or to meet required finish grades.
- C. Apply per 1,000 square feet in all planting areas as shown on Drawings. Incorporate to a depth of 6" within 4 hours of applying mycorrhizal inoculum.

4 cubic yards:	soil amendment
20 pounds:	fertilizer/soil conditioner
20 pounds:	pre-plant fertilizer
5 pounds:	21-0-0
1.5 pounds:	mycorrhizal inoculum

- D. Water areas to settle fill. Add additional fill to achieve correct finish grade.
- E. Upon completion of soil preparation, inspection and approval of Owner's Representative shall be obtained prior to commencement of planting.

3.3 FINISH GRADING

- A. Grade all finish surfaces smooth and even.
- B. Finish grades shall be a minimum of 1" below surface of paved areas or as shown on the Drawings.
- C. Eliminate any existing erosion or construction scars.
- D. Slope drainage patterns away from buildings as per intention of grading plan.

3.4 PLANTING

- A. Under the direction of the Owner's Representative, Contractor may make slight adjustments to plant material location if it reflects the original intention of the Drawings. Major relocation of plant material needs Owner's approval before planting. Do not plant trees or shrubs in drainage swales.
- B. Trees and shrubs shall be planted in holes twice the diameter and 4" deeper than the depth of their containers. Install trees so that the crown of the trunk is 1" higher than the immediate soil level. Install shrubs so that the crown of the trunk is 1/2" higher than the immediate soil level. Backfill around roots shall be firmed to prevent settling. Provide a berm or watering basin for each tree.
- C. Install fertilizer packets in plant holes per manufacturer instructions at the following rate:
 - 1 Gallon: 1 packet
 - 5 Gallon: 3 packets
 - 15 Gallon: 6 packets

3.5 WEED CONTROL

- A. Apply pre-emergent weed control to all planting areas after completion of all planting and one complete watering. Follow manufacturer's directions. After applying weed control, do not over water shrub areas, to prevent washing away of weed control.

3.6 TOP DRESSING

- A. Bark Mulch Top Dressing: Place uniformly to a 3" depth over pre-emergent herbicide.
- B. Gravel: Place 3" deep over filter fabric. Lap fabric joints 8 inches. Cut out 12" diameter circle from fabric at each plant. Finish grade of gravel to be flush with finish grade of adjacent paving.

3.7 CLEAN-UP

- A. During construction, the Contractor shall keep the site free of rubbish and debris, and shall clean up the site promptly when notified to do so. Care should be taken to prevent spillage on streets from hauling; and any such spillage and debris deposited on streets due to the Contractor's operations, shall be immediately cleaned up.
- B. During all phases of the construction work, the Contractor shall take all precautions to abate dust nuisance by cleanup, sweeping, sprinkling with water, or other means as necessary.

3.8 MAINTENANCE

A. General

1. Protect all landscape areas. Damaged material and components shall be repaired or replaced at Contractor's expense.
2. Keep trash removed from all landscape areas.
3. Maintain all landscaped areas during the course of construction.
4. Improper maintenance or poor condition of the plant material at the termination of the scheduled maintenance period may cause postponement of the final completion date of the project. Maintenance shall be continued until all work for the total project is acceptable.

B. Trees, plants, and groundcovers

1. Maintain all plant material in a healthy, growing condition.
2. Provide control of pests, animals, and diseases as needed.
3. Provide weed control as needed in landscape and mulch areas. Use of pre-emergent and other herbicides is permitted if compatible with type of plant material. Apply per manufacturer recommendations.
4. Prune only to remove dead or diseased branches and promote proper growth.
5. Irrigate as needed.

C. Irrigation System

1. Maintain irrigation system in a properly functioning condition.
2. Adjust watering schedule to provide the correct amount of water based on site and weather conditions.
3. Repair all damage to irrigation system within 24 hours.
4. Drip System
 - a. Periodically inspect and clean filters per manufacturer's recommendations.
 - b. Periodically inspect the operation indicators while in operation to determine if service or repairs are required.
 - c. Periodically inspect each drip zone while in operation. Inspections should occur at the beginning of the irrigation season, after planting, and after any digging has occurred in the zone area. Look for excessively dry or wet areas.

3.9 GUARANTEE

- A. Owner's Representative may reject any plant material which is damaged, diseased, in a state of decline, or dead. The Contractor shall immediately replace any rejected material at his expense. All replacement materials or installations shall conform to the Construction Documents. Replaced plant materials shall be guaranteed for one-half of the initial guarantee period.

3.10 MAINTENANCE AND GUARANTEE PERIODS

- A. Maintenance period shall be for ninety (90) calendar days. Maintenance period begins when all elements of construction, planting, and irrigation for the entire project are completed in accordance with the Construction Documents and accepted by the Owner or Representative.
- B. The Contractor shall guarantee all plant materials and other materials for 90 days minimum from date landscape installation is accepted as complete.
- C. If the 90 day maintenance and guarantee period begins between December 15 and March 15, the 90 day period shall begin after March 15. If the 90 day maintenance and guarantee period ends between December 15 and March 15, the 90 day period shall be extended after March 15 the number of days falling within the period. In both cases, the Contractor is responsible for maintenance and guarantee between December 15 and March 15.

3.11 FINAL ACCEPTANCE

- A. Upon completion of all project work, including the maintenance period, the Contractor shall submit a written request to the Owner to conduct an observation and determine the acceptability of the project.
- B. When observed work does not comply with the Construction Documents, replace rejected work and continue maintenance period until Owner re-inspects and accepts the project.
- C. Prior to the date of final observation, the Contractor shall provide the Owner with all record drawings, written instructions, components, and close out submittals as described in the Construction Documents.
- D. Prior to final acceptance, Contractor shall submit a Certification of Installation and/or other required documentation to the County of Humboldt.

END SECTION

PART 1 GENERAL

1.01 DESCRIPTION

A. Section Includes:

1. Testing Manholes:
 - a. Vacuum Test.
 - b. Exfiltration Test.
2. Testing Gravity Sewer Piping:
 - a. Low-pressure Air Test.
 - b. Infiltration Test.
3. Hydrostatic Testing Pressure Piping.
4. Deflection Testing Plastic Piping.

B. Related Sections:

1. Section 33 31 00 Sanitary Utility Sewerage Piping
2. Section 33 05 13 – Manholes and Structures

1.02 REFERENCES

A. ASTM International:

1. ASTM C1244 - Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test.
2. ASTM D2122 - Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings.

B. Requirements of General Conditions and Division 1 apply to all work in this Section.

1.03 SUBMITTALS

A. Submit the following prior to start of testing:

1. List of test equipment.
2. Testing sequence schedule.
3. Provisions for disposal of flushing and test water.
4. Certification of test gauge calibration.
5. Deflection mandrel drawings and calculations.

B. Test Reports: Indicate results of manhole and piping tests.

PART 2 PRODUCTS

2.01 EXFILTRATION TEST EQUIPMENT

- A. Plugs.
- B. Pump.
- C. Measuring device.

2.02 AIR TEST EQUIPMENT

- A. Air compressor.
- B. Air supply line.
- C. Shut-off valves.
- D. Pressure regulator.
- E. Pressure relief valve.
- F. Stop watch.
- G. Plugs.
- H. Pressure gauge, calibrated to 0.1 psi.

2.03 INFILTRATION TEST EQUIPMENT

- A. Weirs.

2.04 HYDROSTATIC TEST EQUIPMENT

- A. Hydro pump.
- B. Pressure hose.
- C. Water meter.
- D. Test connections.
- E. Pressure relief valve.
- F. Pressure gauge, calibrated to 0.1 psi.

2.05 DEFLECTION TEST EQUIPMENT

- A. Go, No-Go mandrels.
- B. Pull/retrieval ropes.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify manholes and piping are ready for testing.
- B. Verify trenches are backfilled.
- C. Verify pressure piping concrete reaction support blocking or mechanical restraint system is installed.

3.02 PIPING PREPARATION

- A. Lamping:
 - 1. Lamp gravity piping after flushing and cleaning.
 - 2. Perform lamping operation by shining light at one end of each pipe section between manholes; observe light at other end; reject pipe not installed with uniform line and grade; remove and reinstall rejected pipe sections; re-clean and lamp until pipe section achieves uniform line and grade.
- B. Plug outlets, wye-branches and laterals; brace plugs to resist test pressures.

3.03 FIELD QUALITY CONTROL

- A. Testing Gravity Sewer Piping:
 - 1. Low-pressure Air Test:
 - a. Test each section of gravity sewer piping between manholes.
 - b. Introduce air pressure slowly to approximately 4 psig.
 - 1) Determine ground water elevation above spring line of pipe for every foot of ground water above spring line of pipe, increase starting air test pressure by 0.43 psig; do not increase pressure above 10 psig.
 - c. Allow pressure to stabilize for at least five minutes. Adjust pressure to 3.5 psig or increased test pressure as determined above when ground water is present. Start test.
 - d. Test:
 - 1) Determine test duration for sewer section with single pipe size from the following table. Do not make allowance for laterals.

Nominal Pipe Size, Inches	Minimum Test Time, min/ 100 feet
<3	0.1
3	0.2
4	0.3
6	0.7
8	1.2
10	1.5

12	1.8
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- 2) Record drop in pressure during test period; when air pressure has dropped more than 1.0 psig during test period, piping has failed; when 1.0 psig air pressure drop has not occurred during test period, discontinue test and piping is accepted.
- 3) When piping fails, determine source of air leakage, make corrections and retest; test section in incremental stages until leaks are isolated; after leaks are repaired, retest entire section between manholes.

2. Infiltration Test:

- a. Use only when gravity piping is submerged in ground water minimum of 4 feet above crown of pipe for entire length being tested.
- b. Maximum Allowable Infiltration: 100 gallons per inch of pipe diameter for each mile per day for section under test, include allowances for leakage from manholes. Perform test with minimum positive head of 2 feet.

B. Testing Pressure Sewer Piping:

1. Hydrostatic Leakage Test:

- a. Hydrostatically test each portion of pressure piping, including valved section, at 1.5 times working pressure of piping based on elevation of lowest point in piping corrected to elevation of test gauge.
- b. Fill section to be tested with water slowly, expel air from piping at high points. Install corporation cocks at high points. Close air vents and corporation cocks after air is expelled and raise pressure to specified test pressure.
- c. Observe joints, fittings and valves under test. Remove and renew cracked pipe, joints, fittings, and valves showing visible leakage. Retest.
- d. Correct visible deficiencies and continue testing at same test pressure for additional 2 hours to determine leakage rate. Maintain pressure within plus or minus 5.0 psig of test pressure. Leakage is defined as quantity of water supplied to piping necessary to maintain test pressure during period of test.
- e. Compute maximum allowable leakage by the following formula:

$$L = (SD\sqrt{P})/C$$

L = allowable, in gallons per hour

S = length of pipe tested, in feet

D = nominal diameter of pipe, in inches

p = average test pressure during leakage test, in psig

C = 133,200

When pipe under test contains sections of various diameters, calculate allowable leakage from sum of computed leakage for each size.

- f. When test of pipe indicates leakage greater than allowed, locate source of leakage, make corrections and retest until leakage is within allowable limits. Correct visible leaks regardless of quantity of leakage.

C. Deflection Testing of Plastic Sewer Pipe:

1. Perform vertical ring deflection testing on PVC and ABS sewer piping, after backfilling has been in place for at least 30 days but not longer than 12 months.
2. Allowable maximum deflection for installed plastic sewer pipe limited to 5 percent of original vertical internal diameter.
3. Perform deflection testing using properly sized rigid ball or 'Go, No-Go' mandrel.
4. Furnish rigid ball or mandrel with diameter not less than 95 percent of base or average inside diameter of pipe as determined by ASTM standard to which pipe is manufactured. Measure pipe in compliance with ASTM D2122.
5. Perform test without mechanical pulling devices.
6. Locate, excavate, replace and retest pipe exceeding allowable deflection.

D. Testing Manholes:

1. General: Test using air whenever possible prior to backfilling to assist in locating leaks. Make joint repairs on both outside and inside of joint to ensure permanent seal. Test manholes with manhole frame set in place.
2. Exfiltration Test:
 - a. Plug pipes in manhole; remove water in manhole; observe plugs over period of not less than 2 hours to ensure there is no leakage into manhole.
 - b. Determine ground water level outside manhole.
 - c. Fill manhole with water to within 4 inches of top of cover frame. Prior to test, allow manhole to soak from minimum of 4 hours to maximum of 72 hours; after soak period, adjust water level inside manhole to within 4 inches of top of cover frame.
 - d. Measure water level from top of manhole frame; at end of 4 hour test period, again measure water level from top of manhole frame; compute drop in water level during test period.
 - e. Manhole exfiltration test is considered satisfactory when drop in water level is less than values listed in table below:

Manhole Depth (feet)	Allowable Leakage inches for Manhole Diameter		
	4 feet	5 feet	6 feet
4	0.11	0.14	0.17
6	0.17	0.21	0.26
8	0.23	0.29	0.35
10	0.28	0.35	0.42
12	0.34	0.43	0.51

3. When unsatisfactory test results are achieved, repair manhole and retest until result meets criteria; repair visible leaks regardless of quantity of leakage.

END OF SECTION

PART 1 GENERAL

1.01 DESCRIPTION

A. Section Includes:

1. Pipe and fittings for site water line including domestic water line and fire water line.
2. Valves.
3. Underground pipe markers.
4. Bedding and cover materials.

B. Related Sections:

1. Section 31 20 00 – Earth Moving
2. Section 31 23 17 – Trenching: Execution requirements for trenching required by this section.
3. Section 33 13 00 – Disinfection of Water Utility Distribution: Disinfection of site service utility water piping.

C. Requirements of General Conditions and Division 1 apply to all work in this Section.

1.02 REFERENCES

A. ASTM International:

1. ASTM D1557 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (6,000 ft-lbf/ft³ (2,700 kN-m/m³)).
2. ASTM D1785 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
3. ASTM D2466 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
4. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
5. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
6. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
7. ASTM D3035 - Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter.
8. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.

B. American Water Works Association:

1. AWWA C104 - American National Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
2. AWWA C105 - American National Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems.

3. AWWA C111 - American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
4. AWWA C151 - American National Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water.
5. AWWA C500 - Metal-Seated Gate Valves for Water Supply Service.
6. AWWA C509 - Resilient-Seated Gate Valves for Water-Supply Service.
7. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.
8. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe, 4 in. through 12 in., for Water Distribution.

1.03 SUBMITTALS

- A. Product Data: Submit data on pipe materials, pipe fittings, valves and accessories.
- B. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.
- C. Submit the following prior to start of pressure testing:
 1. List of test equipment.
 2. Testing sequence schedule.
 3. Provisions for disposal of flushing and test water.
 4. Certification of test gauge calibration.
 5. Test Reports: Indicate results of water piping tests.

1.04 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of piping mains, valves, connections, thrust restraints, and invert elevations.
- B. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.05 QUALITY ASSURANCE

- A. Perform Work in accordance with local standards.
- B. Maintain one copy of each document on site.
- C. Valves: Manufacturer's name and pressure rating marked on valve body.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store valves in shipping containers with labeling in place.

PART 2 PRODUCTS

2.01 WATER PIPING

- A. Ductile Iron Pipe: AWWA C151:
 - 1. Fittings: Ductile iron, standard thickness.
 - 2. Joints: AWWA C111, rubber gasket with rods.
 - 3. Jackets: AWWA C105 polyethylene jacket.
- B. PVC Pipe: ASTM D1785, Schedule 40 ASTM D1785:
 - 1. Fittings: ASTM D2466, PVC.
 - 2. Joints: ASTM D2855, solvent weld.
- C. PVC Pipe: AWWA C900 Class 150:
 - 1. Fittings: AWWA C111, ductile iron.
 - 2. Joints: ASTM D3139 compression gasket ring.
- D. Polyethylene Pipe: AWWA C901:
 - 1. Fittings: AWWA C901, fabricated.
 - 2. Joints: Butt fusion.

2.02 GATE VALVES

- A. 2-1/2 inches and Smaller: Brass or Bronze body, non-rising stem, inside screw, single wedge or disc.
- B. See Section 33 12 16

2.03 TAPPING SLEEVES

- A. Tapping sleeves shall be ductile iron, epoxy coated steel, or stainless steel fittings, two piece bolted sleeve with flanged outlet for new branch connection. Branch outlet from tapping sleeve shall be Schedule 40 minimum. Sleeve shall conform to locally municipality requirements. Manufactured by Waterous, Clow, Kennedy, Mueller, or approved equal. Standard: MSS SP-60.

2.04 UNDERGROUND PIPE MARKERS

- A. Plastic Ribbon Tape: Bright colored, continuously printed, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.
- B. Trace Wire: Magnetic detectable conductor, brightly colored plastic covering, imprinted with "Water Service" in large letters.

2.05 BEDDING AND COVER MATERIALS

- A. Bedding: Bedding as specified in Section 31 20 00.

- B. Cover: Cover as specified in Section 31 20 00.
- C. Backfill: Backfill as specified in Section 31 20 00.

2.06 ACCESSORIES

- A. Concrete for Thrust Restraints: Concrete type specified in Section 03 30 00.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify building service connection and municipal utility water main size, location, and invert are as indicated on Drawings.

3.02 PREPARATION

- A. Cut pipe ends square, ream pipe and tube ends to full pipe diameter, remove burrs.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare pipe connections to equipment with flanges or unions.

3.03 BEDDING

- A. Excavate pipe trench in accordance with Section 31 20 00 for Work of this Section.
- B. Form and place concrete for pipe thrust restraints at change of pipe direction. Place concrete to permit full access to pipe and pipe accessories.
- C. Place bedding material at trench bottom, level fill materials in one continuous layer not exceeding 8 inches compacted depth; compact to 95 percent.
- D. Backfill around sides and to top of pipe with cover fill, tamp in place and compact to 95 percent.
- E. Place fill material in accordance with Section 31 20 00.

3.04 INSTALLATION - PIPE

- A. Maintain a 10' separation of water main from sewer piping in accordance with State code.
- B. Group piping with other site piping work whenever practical and in conformance with California DHS Separation Standards.
- C. Install pipe to indicated elevation to within tolerance of 5/8 inches.
- D. Install ductile iron piping and fittings to AWWA C600.
- E. Install Work in accordance with Local standards.

3.05 INSTALLATION - VALVES AND HYDRANTS

- A. Set valves on solid bearing soil and thrust blocks as shown on the plans.
- B. Center and plumb valve box over valve. Set box cover flush with finished grade.
- C. Install Work in accordance with Local standards.

3.06 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

- A. Flush and disinfect system in accordance with Section 33 13 00.

3.07 FIELD QUALITY CONTROL

- A. Pressure test system to [200] psi. Repair leaks and re-test.
 - 1. After completion of pipeline installation, including backfill, but prior to final connection to existing system, conduct, in presence of Engineer, concurrent hydrostatic pressure and leakage tests in accordance with AWWA C600.
 - 2. Provide equipment required to perform leakage and hydrostatic pressure tests.
 - 3. Test Pressure: Not less than 200 psi or 50 psi in excess of maximum static pressure, whichever is greater.
 - 4. Conduct hydrostatic test for at least two-hour duration.
 - 5. No pipeline installation will be approved when pressure varies by more than 5 psi at completion of hydrostatic pressure test.
 - 6. Before applying test pressure, completely expel air from section of piping under test. Provide corporation cocks so air can be expelled as pipeline is filled with water. After air has been expelled, close corporation cocks and apply test pressure. At conclusion of tests, remove corporation cocks removed and plug resulting piping openings.
 - 7. Slowly bring piping to test pressure and allow system to stabilize prior to conducting leakage test. Do not open or close valves at differential pressures above rated pressure.
 - 8. Examine exposed piping, fittings, valves, hydrants, and joints carefully during hydrostatic pressure test. Repair or replace damage or defective pipe, fittings, valves, hydrants, or joints discovered, following pressure test.
 - 9. No pipeline installation will be approved when leakage is greater than that determined by the following formula:

$$L = \frac{SD\sqrt{P}}{133,200}$$

L = allowable, in gallons per hour
S = length of pipe tested, in inches
D = nominal diameter of pipe, in inches
p = average test pressure during leakage test, in pounds per square inch (gauge)

10. When leakage exceeds specified acceptable rate, locate source and make repairs. Repeat test until specified leakage requirements are met.

END OF SECTION

PART 1 GENERAL

1.01 DESCRIPTION

A. Section Includes:

1. Valves.
2. Fire hydrants.
3. Valve boxes.

B. Related Sections:

1. Section 31 20 00 - Earth Moving
2. Section 33 11 16 - Site Water Utility Distribution Piping
3. Section 33 13 00 - Disinfection of Water Utility Distribution

C. Requirements of General Conditions and Division 1 apply to all work in this Section.

1.02 REFERENCES

A. American Water Works Association:

1. AWWA C500 - Metal-Seated Gate Valves for Water Supply Service.
2. AWWA C503 - Wet-Barrel Fire Hydrants.
3. AWWA C509 - Resilient-Seated Gate Valves for Water-Supply Service.
4. AWWA C550 - Protecting Epoxy Interior Coating for Valves and Hydrants.
5. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.

B. National Sanitation Foundation:

1. NSF 61 - Drinking Water System Components - Health Effects

C. National Fire Protection Association:

1. NFPA 24 – Installation of Private Fire Service Main and Their Appurtenances
2. NFPA 281 - Recommended Practice for Fire Flow Testing and Marking of Hydrants

1.03 SUBMITTALS

A. Shop Drawing:

1. Installation Plan: Submit description of proposed installation.

B. Design Data: Submit manufacturer's latest published literature including illustrations, installation instructions, maintenance instructions and parts lists.

- C. Manufacturer's Certificates: Submit Statement of Compliance, supporting data, from material suppliers attesting that valves, hydrants, and accessories provided meet or exceed AWWA Standards and specification requirements.
- D. Submit the following prior to start of pressure testing:
 - 1. List of test equipment.
 - 2. Testing sequence schedule.
 - 3. Provisions for disposal of flushing and test water.
 - 4. Certification of test gauge calibration.
 - 5. Test Reports: Indicate results of water piping tests.

1.04 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of valves and fire hydrants.
- B. Provide Operation and Maintenance Data for valves and fire hydrants.

1.05 QUALITY ASSURANCE

- A. Perform work in accordance with local standards.
- B. Maintain one copy of each document on site.
- C. Provide uniform color scheme for fire hydrants in accordance with NFPA 281 and local Fire Department Standards.

1.06 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing work of this section with minimum five (5) years documented experience.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Prepare valves, hydrants and accessories for shipment according to AWWA Standards and seal valve, hydrant and ends to prevent entry of foreign matter into product body.
- B. Store products in areas protected from weather, moisture, or possible damage; do not store products directly on ground; handle products to prevent damage to interior or exterior surfaces.

1.08 ENVIRONMENTAL REQUIREMENTS

- A. Conduct operations not to interfere with, interrupt, damage, destroy, or endanger integrity of surface or subsurface structures or utilities, and landscape in immediate or adjacent areas.

1.09 COORDINATION

- A. Coordinate work with Owner and utilities within construction area.

1.10 MAINTENANCE MATERIALS

- A. Furnish one tee wrench to Owner; required length.

PART 2 PRODUCTS

2.01 RESILIENT WEDGE GATE VALVES

- A. Furnish materials in accordance with local standards.
- B. Resilient Wedge Gate Valves: AWWA C509; iron body, bronze or ductile iron.
 - 1. Resilient seats.
 - 2. Stem: Non-rising bronze stem.
 - 3. Operating Nut: Square; open counterclockwise unless otherwise indicated.
 - 4. Ends: Flanged, mechanical joint or bell end connections.
 - 5. Coating: AWWA C550; interior/exterior.
 - 6. Sizes 12 inch diameter and smaller: 200 psig.
 - 7. Sizes 16 inch diameter and larger: 150 psig.

2.02 FIRE HYDRANTS

- A. Furnish materials in accordance with local standards.
- B. Wet-Barrel Type: AWWA C503; cast-iron body.
 - 1. Valve Openings: Individual for pumper and hose nozzles.
 - 2. Ends: Mechanical joint or bell end.
 - 3. Bolts and Nuts: Corrosion resistant.
 - 4. Coating: AWWA C550; interior.
- C. One pumper, two hose nozzles.
 - 1. Obtain thread type and size from local fire department.
 - 2. Attach nozzle caps by separate chains.
- D. Finish: Primer and two coats of enamel color in accordance with fire department requirements.

2.03 VALVE BOXES

- A. 12-inch diameter Valves and Smaller: Domestic cast iron, two-piece, screw type.
- B. Valves larger than 12-inch diameter: Domestic cast iron, three-piece, screw type; round base.
- C. Cast iron lid marked "Water."

2.04 ACCESSORIES

- A. Concrete for Thrust Restraints: Concrete type specified in Section 03300.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Determine exact location and size of valves and hydrants from Drawings; obtain clarification and directions from Architect/Engineer prior to execution of work.
- B. Verify invert elevations prior to excavation and installation of valves and fire hydrants.

3.02 PREPARATION

- A. Identify required lines, levels, contours and datum locations.
- B. Locate, identify, and protect utilities to remain from damage.
- C. Do not interrupt existing utilities without permission and without making arrangements to provide temporary utility services.
 - 1. Notify the Owners Representative not less than 3 days in advance of proposed utility interruption.
 - 2. Do not proceed without written permission from the Engineer.
- D. Perform trench excavation, backfilling and compaction in accordance with Section 02324.

3.03 INSTALLATION

- A. Gate Valves:
 - 1. Install valves in conjunction with pipe laying; set valves plumb.
 - 2. Provide buried valves with valve boxes installed flush with finished grade.
- B. Fire Hydrants:
 - 1. Install fire hydrants; provide support blocking and drainage gravel; do not block drain hole.
 - 2. Set hydrants plumb with pumper nozzle facing roadway; set hydrants with centerline of pumper nozzle 18 inches above finished grade and safety flange not more than 6 inches nor less than 2 inches above grade.
 - 3. Paint hydrants in accordance with local color scheme.
 - 4. After hydrostatic testing, flush hydrants and check for proper drainage.

3.04 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

- A. Flush and disinfect system in accordance with Section 02516.

3.05 FIELD QUALITY CONTROL

- A. Pressure test system to 200 psi. Repair leaks and re-test.
 - 1. After completion of pipeline installation, including backfill, but prior to final connection to existing system, conduct, in presence of Architect/Engineer, concurrent hydrostatic pressure and leakage tests in accordance with AWWA C600.

2. Provide equipment required to perform leakage and hydrostatic pressure tests.
3. Test Pressure: Not less than 200 psi or 50 psi in excess of maximum static pressure, whichever is greater.
4. Conduct hydrostatic test for at least two-hour duration.
5. Before applying test pressure, completely expel air from section of piping under test. Provide corporation cocks so air can be expelled as pipeline is filled with water. After air has been expelled, apply test pressure. At conclusion of tests, close resulting piping openings.
6. Slowly bring piping to test pressure and allow system to stabilize prior to conducting leakage test. Do not open or close valves at differential pressures above rated pressure.
7. Examine exposed piping, fittings, valves, hydrants, and joints carefully during hydrostatic pressure test. Repair or replace damage or defective pipe, fittings, valves, hydrants, or joints discovered, following pressure test.
8. No pipeline installation will be approved when leakage is greater than that determined by the following formula:

$$L = \frac{SD\sqrt{P}}{C}$$

L = allowable, in gallons per hour

S = length of pipe tested, in feet

D = nominal diameter of pipe, in inches

p = average test pressure during leakage test, in pounds per square inch gauge

C = 133,200

9. When leakage exceeds specified acceptable rate, locate source and make repairs. Repeat test until specified leakage requirements are met.

END OF SECTION

PART 1 GENERAL

1.01 DESCRIPTION

- A. Section includes disinfection of potable water distribution [and transmission] system; and testing and reporting results.
- B. Related Sections:
 - 1. Section 33 11 16 - Site Water Utility Distribution Piping Product and Execution
- C. Requirements of General Conditions and Division 1 apply to all work in this Section.

1.02 REFERENCES

- A. American Water Works Association:
 - 1. AWWA B300 - Hypochlorites.
 - 2. AWWA B301 - Liquid Chlorine.
 - 3. AWWA B302 - Ammonium Sulfate.
 - 4. AWWA B303 - Sodium Chlorite.
 - 5. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.
 - 6. AWWA C651 - Disinfecting Water Mains.

1.03 SUBMITTALS

- A. Product Data: Submit procedures, proposed chemicals, and treatment levels for review.
- B. Test Reports: Indicate results comparative to specified requirements.
- C. Provisions for legal disposal of chlorinated water.

1.04 CLOSEOUT SUBMITTALS

- A. Disinfection Report:
 - 1. Type and form of disinfectant used.
 - 2. Date and time of disinfectant injection start and time of completion.
 - 3. Test locations.
 - 4. Name of person collecting samples.
 - 5. Initial and 24 hour disinfectant residuals in treated water in ppm for each outlet tested.
 - 6. Date and time of flushing start and completion.
 - 7. Disinfectant residual after flushing in ppm for each outlet tested.
- B. Bacteriological Report:
 - 1. Date issued, project name, and testing laboratory name, address, and telephone number.
 - 2. Time and date of water sample collection.

3. Name of person collecting samples.
 4. Test locations.
 5. Initial and 24 hour disinfectant residuals in ppm for each outlet tested.
 6. Coliform bacteria test results for each outlet tested.
 7. Certify water conforms, or fails to conform, to bacterial standards.
- C. Water Quality Certificate: Certify water conforms to quality Local and State standards, suitable for human consumption.
- 1.05 QUALITY ASSURANCE
- A. Perform Work in accordance with Local standards.
- 1.06 QUALIFICATIONS
- A. Water Treatment Firm: Company specializing in disinfecting potable water systems specified in this section with minimum three years documented experience.
- B. Submit bacteriologist's signature and authority associated with testing.

PART 2 PRODUCTS

2.01 DISINFECTION CHEMICALS

- A. Chemicals: AWWA B300, Hypochlorite, AWWA B301, Liquid Chlorine, and AWWA B303, Sodium Chlorite.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify piping system has been cleaned, inspected, and pressure tested.
- B. Perform scheduling and disinfecting activity with start-up, water pressure testing, adjusting and balancing, demonstration procedures, including coordination with related systems.

3.02 INSTALLATION

- A. Provide and attach required equipment to perform the Work of this section.
- B. Perform disinfection of water distribution system and installation of system and pressure testing. Refer to Section 33 11 16.
- C. Introduce treatment into piping system.
- D. Maintain disinfectant in system for 24 hours.
- E. Flush, circulate, and clean until required cleanliness is achieved; use Owner's domestic water.
- F. Replace permanent system devices removed for disinfection.

3.03 FIELD QUALITY CONTROL

A. Disinfection, Flushing, and Sampling:

1. Disinfect pipeline installation in accordance with AWWA C651. Use of liquid chlorine is not permitted
2. Upon completion of retention period required for disinfection, flush pipeline until chlorine concentration in water leaving pipeline is no higher than that generally prevailing in existing system or is acceptable for domestic use.
3. Legally dispose of chlorinated water. When chlorinated discharge may cause damage to environment, apply neutralizing chemical to chlorinated water to neutralize chlorine residual remaining in water.
4. After final flushing and before pipeline is connected to existing system, or placed in service, employ an approved independent testing laboratory to sample, test and certify water quality suitable for human consumption.

END OF SECTION

PART 1 GENERAL

1.01 DESCRIPTION

- A. This work consists of the installation of a gravity sewer system and the connections to the building sewer to the sewer system.
- B. Related Sections:
 - 1. Section 33 05 13 – Manholes and Structures
 - 2. Section 33 01 32 – Sewer and Manhole Testing
- C. Requirements of General Conditions and Division 1 apply to all work in this Section.

1.02 REFERENCES

- A. Uniform Plumbing Code (UPC) 1998 Edition
- B. National Sanitation Foundation (NSF)
- C. International Association of Plumbing and Mechanical Officials (IAPMO) Installation Standards (UPC-IS)

1.03 LICENSED CONTRACTOR

- A. All work under this section shall be performed by a licensed general contractor for the installation of underground utilities.

PART 2 PRODUCTS

2.01 SEWER LINE

- A. Gravity sewer lines, and building drainlines shall be of the size shown on the drawings. Pipe shall be PVC underground, solid wall pipe with SDR-35 rating unless shown otherwise on the plans.
- B. Sewer force mains and leachfield lines shall be schedule 40 PVC or better, unless shown otherwise on the plans.
- C. Reclaimed water lines shall be purple schedule 40 PVC or better, unless shown otherwise on the plans. Reclaimed water lines shall be marked "Reclaimed Water...Do Not Drink."
- C. All fittings and accessories shall be as manufactured and furnished by the pipe supplier and compatible with that of the pipe.

2.02 CLEANOUTS

- A. Cleanouts shall be of the same size and material as the sewer line. Cleanout boxes shall be precast concrete boxes with cast iron frame and cover marked "sewer" or "CO," Christy No. G-5 or approved equal.

2.03 MARKING TAPE

- A. Marking tape shall be 2 inches wide with imprint "Caution - Buried Sewerline Below"; color shall be blue. Tape shall be as manufactured by Calpico Inc., or an approved equal.

- B. Where more than one utility is located in a common trench marking type shall be 6 inches wide with imprint "Caution - Buried Utility Lines Below"; color shall be red.

PART 3 EXECUTION

3.01 INSTALLATION

- A. No pipe shall be laid until the trench subgrade and bedding have been inspected and approved.
- B. Laying of lines shall begin at the lowest point in the direction of flow. All piping, fittings, and accessories shall be assembled per manufacturers recommendations and in accordance with the UPC. Pipe deflections shall be kept to a minimum, any deflection of piping shall be per manufacturer's requirements.
- C. Before lowering pipe into the trench, the pipe shall be inspected. Cracked, chipped, broken, or otherwise defective pipe will be rejected and removed from the job site. The ends and interior of the pipe shall be clean.
- D. Cleanouts shall be installed where shown on the plans and at changes in direction more than 22.5 degrees.
- E. Where waterline is being crossed, pipelines of twenty-foot length shall be used with the length centered to provide ten foot of distance from the waterline to the nearest sewer or drain line joint. Where water and sewer lines cross, the waterline shall be installed a minimum of 12 inches horizontally and vertically above the top of the sewer line, and constructed on a solid shelf on one side of the trench

3.02 BEDDING AND BACKFILL MATERIAL

- A. Lines shall be bedded in material as specified in Section 31 20 00, Earth Moving, and as shown on the drawings.
- B. Marking tape, appropriately color coded and marked, shall be placed above the lines 6 to 12 inches below finish ground grade and as shown on the drawings.

3.03 CLEANING LINES

- A. All sections of pipe shall be cleaned with an inflatable rubber ball of a size that will inflate to fit snugly into the pipe. The ball may be used without a tag line. The ball shall be placed in the last cleanout, manhole, or entry on the pipe to be cleaned, and water shall be introduced behind it. The ball shall pass through the pipe with only the force of the water impelling it. All debris flushed out ahead of the ball shall be removed at the first location or manhole where its presence is noted. In the event that wedged debris, or a damaged pipe, shall stop the ball, the contractor shall remove the obstruction, or make suitable repairs.

3.04 TESTING

- A. Sewer lines shall be tested for leaks. See Section 33 01 32.

END OF SECTION

PART 1 GENERAL

1.01 DESCRIPTION

A. Section Includes:

1. Storm Drainage Piping
2. Catch Basins

B. Related Sections:

1. Section 31 20 00 - Earth Moving
2. Section 31 23 17 - Trenching: Execution requirements for trenching required by this section.

C. Requirements of General Conditions and Division 1 apply to all work in this Section.

1.02 REFERENCES

A. ASTM International:

1. ASTM D1557 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (6,000 ft-lbf/ft³ (2,700 kN-m/m³)).
2. ASTM D2235 - Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.
3. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
4. ASTM D2564 - Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
5. ASTM D2729 - Standard Specification for Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
6. ASTM D2751 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings.
7. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
8. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
9. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
10. ASTM D3034 - Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
11. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

1.03 SUBMITTALS

A. Product Data: Submit data indicating product and product accessories.

B. Manufacturer's Installation Instructions: Submit special procedures required to install Products specified.

1.04 QUALITY ASSURANCE

- A. Perform Work in accordance with Local standards.
- B. Maintain two copies of each document on site.

1.05 COORDINATION

- A. Coordinate the Work with termination of storm sewer connection outside building, trenching, and connection to foundation drainage system.

PART 2 PRODUCTS

2.01 STORM DRAINAGE PIPING

- A. 6" and larger: ADS N-12 Dual Wall Corrugated Pipe, bell and spigot joint.
 - 1. Rubber gasket meeting ASTM F477.
- B. Less than 6": PVC meeting ASTM D2729 or ABS piping, solvent weld.

2.02 CATCH BASINS

- A. Catch Basins: Catch basins shall conform to Caltrans Standard Plans and Specifications unless noted otherwise.

2.03 BEDDING AND COVER MATERIALS

- A. Bedding: Bedding as specified in Section 31 20 00.
- B. Cover: Cover as specified in Section 31 20 00.
- C. Backfill: Backfill as specified in Section 31 20 00.

PART 3 EXECUTION

3.01 PREPARATION

- A. Hand trim excavations to required elevations. Correct over excavation with Native material.
- B. Remove large stones or other hard matter which could damage piping or impede consistent backfilling or compaction.

3.02 BEDDING

- A. Excavate pipe trench in accordance with Section 31 20 00 for work of this Section. Hand trim excavation for accurate placement of pipe to elevations indicated.

- B. Place bedding material at trench bottom, level materials in continuous layer.
- C. Maintain optimum moisture content of bedding material to attain required compaction density.

3.03 INSTALLATION - PIPE

- A. No pipe shall be laid until the trench subgrade and bedding have been inspected and approved.
- B. Laying of lines shall begin at the lowest point in the direction of flow. All piping, fittings, and accessories shall be assembled per manufacturer's recommendations. Pipe deflections shall be kept to a minimum, any deflection in piping shall be per manufacturer's requirements.
- C. Before lowering pipe into the trench, the pipe shall be inspected. Cracked, chipped, broken, or otherwise defective pipe will be rejected and removed from the job site.
- D. Manholes shall be placed as shown on the plans.
- E. Where sewer lines are being crossed, pipelines of 20 foot lengths shall be used with the length centered to provide 10 feet of distance from the sewer line to the nearest joint.
- F. Install site storm drainage system piping to 5 feet of building. Connect to building storm drainage system.
- G. Install Work in accordance with Local standards.

3.04 INSTALLATION - CLEANOUT

- A. Cleanouts shall be constructed as shown on the Plans.
- B. The end of the bottom wye shall be tightly plugged with mechanical plug if necessary.
- C. The lower wye section shall be encased in concrete to prevent breakage from ditch settlement.
- D. The riser shall be braced in place and properly compacted.
- E. The frame shall be insulated from riser pipe with a flexible asphalt felt or rubber connection so as to exclude water and to prevent direct traffic bearing against riser section.
- F. Cleanout covers and the surrounding concrete ring shall be raised to an elevation slightly above the surrounding road surface so that rainfall does not flow onto the cleanout cover.

3.05 INSTALATION - CATCH BASIN

- A. Catch basin units shall be installed on a minimum 6" pad of level class II aggregate base. See Section 31 20 00.
- B. Wall sides to be plumb.

- C. Establish elevations and pipe inverts for inlets and outlets as indicated on Drawings
- D. Mount lid and frame level in grout, secured to top cone section to elevation indicated.
- E. The catch basin rim elevations shall be installed within the tolerance of +0.00' and -0.10' from the rim elevations shown on the plan.
- F. The finish grade around the catch basin inlet must slope to drain storm water into the catch basin, refer to the grading plan. No depressions will be permitted adjacent to the catch basin rim.
- G. Install Work in accordance with Local standards.

3.06 CLEANOUTS

- A. Form bottom of excavation clean and smooth to correct elevation.
- B. Establish elevations and pipe inverts for inlets and outlets as indicated on Drawings.
- C. Mount lid/grate and frame level in grout, secured to top cone section to elevation indicated.
- D. Install in accordance with manufacturers recommendations and local standards.

3.07 PROTECTION OF FINISHED WORK

- A. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.
 - 1. Take care not to damage or displace installed pipe and joints during construction of pipe supports, backfilling, testing, and other operations.
 - 2. Repair or replace pipe that is damaged or displaced from construction operations.

END OF SECTION



APPENDIX A

Foundation Plan Review Letter & Geotechnical Engineering Report

County of Humboldt Community Corrections Re-Entry Resource Center

PROJECT NUMBER: 170223
CSFM APPLICATION NO. 19-N-0964-CP-DR



February 9, 2022





MID PACIFIC ENGINEERING, INC.

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GEOTECHNICAL ENGINEERING | EARTHWORK TESTING | MATERIALS ENGINEERING AND TESTING | CONSTRUCTION INSPECTION

Mr. Jake Johnson, Architect
Construction Projects Manager
Humboldt County Public Works
1106 2nd Street
Eureka, California 95501

July 22, 2020

Foundation Plan Review

HUMBOLDT COUNTY COMMUNITY CORRECTION RE-ENTRY RESOURCE CENTER

826 4th Street
Eureka, California
MPE No. 04769-01

As requested, Mid Pacific Engineering, Inc. has prepared this foundation plan review letter for the Humboldt County Community Correction Re-entry Resource Center project to be constructed at 826 4th Street in Eureka, California. The purpose of our work has been to note compliance of the Geotechnical-related items contained in project Structural drawings with the recommendations of our *Geotechnical Engineering Report Update and Supplemental Recommendations* (MPE No. 04769-01, dated November 29, 2019).

We reviewed the following (95% Construction Documents) Structural plan sheets for the subject project prepared by Nichols, Melburg, & Rossetto and Lionakis.

- Sheet S001 (*Date Issued: January 24, 2020*)
- Sheet S011 (*Date Issued: January 24, 2020*)
- Sheet S200 (*Date Issued: January 24, 2020*)
- Sheets S301 through S304 (*Date Issued: January 24, 2020*)
- Sheet S534 (*Date Issued: May 28, 2020 and Dated Revised: July 20, 2020*)

The Geotechnical-related items contained in the listed drawings were reviewed with respect to the recommendations of our *Geotechnical Engineering Report Update and Supplemental Recommendations*. It is our opinion that the Geotechnical-related items contained on the reviewed drawings are in general conformance with the recommendations of our report.

We appreciate this opportunity to review the plans for the project and look forward to our continuing association with you during the construction phase of the project. If you have any questions regarding this letter, please contact us.

Mid Pacific Engineering, Inc.



Austin R. Holt
Staff Engineer



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Mr. Jake Johnson
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November 29, 2019

Geotechnical Engineering Report Update and Supplemental Recommendations

HUMBOLDT COUNTY COMMUNITY CORRECTIONS RE-ENTRY RESOURCE CENTER

826 4th Street
Eureka, California
MPE No. 04769-01-01

As requested, Mid Pacific Engineering (MPE) has completed our review and update of the *Geotechnical Investigation Report, Humboldt County, New Courts Facility, Eureka, California* (prepared by Kleinfelder, Inc., Job No. 41-2467-01/001, dated April 3, 1996) for the proposed project site. It is our understanding the currently proposed project will be a Re-Entry Resource Center to be located at 826 4th Street in Eureka, California. The purposes of our work have been to investigate the project site, soil and groundwater conditions, evaluate the applicability of the original report, and provide supplemental conclusions and recommendations regarding design and construction of the proposed structure and associated improvements.

SCOPE OF WORK

Our scope of work included the following:

1. Site reconnaissance;
2. Review of available geologic, seismic, soil, groundwater data containing the site, and historic Google Earth images;
3. Review of the following documents:
 - *Geotechnical Investigation Report, Humboldt County, New Courts Facility, Eureka, California*, prepared by Kleinfelder, Inc. (Job No. 41-2467-01/001, dated April 3, 1996).
 - *Humboldt County Community Corrections Re-Entry Resource Center project plans* (prepared by Nichols, Melburg & Rossetto, dated March 7, 2019).



4. Subsurface investigation, including the advancement of three Cone Penetration Tests (CPT) to an approximate maximum depth of 50 feet below ground surface and the excavation, logging, and sampling of three exploratory test pits to an approximate maximum depth of ten feet below existing ground surface within proposed structural areas;
5. Collection of bulk soil samples at various depths within the test pits;
6. Laboratory testing of selected soil samples;
7. Engineering analysis; and,
8. Preparation of this report.

This report update is specific to the design and construction of the proposed Humboldt County Community Corrections Re-Entry Resource Center structure and associated improvements to be located at 826 4th Street in Eureka, California. This report should not be used for design or construction of any other proposed future buildings or structures at the site without review of the proposed improvements by our office. Additional reports and site investigations may be required for future buildings, groups of buildings, or structures, depending on the proposed development.

FIGURES AND ATTACHMENTS

This report contains a Vicinity Map as Figure 1; a Regional Geologic Map as Figure 2, showing previously mapped project vicinity geology; a Site Investigation Map as Figure 3, showing approximate CPT and test pit locations; and, Logs of Test Pits as Figures 4 and 5. An explanation of the symbols and classification systems used on the test pit logs is included as Figure 6. Appendix A contains information of a general nature regarding project concepts, exploratory methods used during the field phase of our investigation, an explanation of laboratory testing accomplished, and laboratory test results. Appendix B contains *Guide Earthwork Specifications* that may be used in the preparation of contract plans and documents. Appendix C contains the CPT data collected during our field investigation. Appendix D contains the results of our liquefaction analyses. A copy of the Kleinfelder *Geotechnical Investigation Report* is attached to this report as Appendix E.

PROJECT DESCRIPTION

Review of the project plans indicates the project will consist of constructing a three-story, concrete and concrete masonry unit Re-Entry Resource Center supported by a conventional foundation with an interior concrete slab-on-grade first floor and a partial below grade

parking garage. Moderate floor and structural loads are anticipated for the Re-Entry Center. Associated development is anticipated to include retaining walls, an elevator, asphalt paved parking areas, underground utilities, and typical landscaping.

Based on conversations with the project Structural Engineer, it is our understanding a minimum soil bearing capacity of 3,500 pounds per square foot (psf) for dead plus live load conditions is preferred for support of the proposed resource center. Based on our discussions with Structural Engineer, we understand that the planned foundation will be embedded a minimum of 3 to 3½ feet below finished soil pad elevation.

FINDINGS

SITE DESCRIPTION & HISTORY

Review of Google Earth images and historical aerial photographs indicate the proposed project site was previously occupied by several structures from as early as 1940 until at least 1990. Artificial fill soils are present within the project site. The proposed project will be located within a currently gravel and concrete covered parking lot at the northwest corner of the intersection of K Street and Redwood Highway, on the east side of the Humboldt County Jail in Eureka, California. The site is generally bounded to the north by a gravel parking lot, to the east by K Street, to the south by Redwood Highway, and to the west by the existing County Jail. Site topography slopes gently down to the north.

Review of the United States Geological Survey (USGS) *Eureka Quadrangle, California – Humboldt County, 7.5-Minute Series* (2018) and the *County of Humboldt Department of Public Works, Humboldt County Community Corrections Reentry Resource Center, Topographic Map* (dated July 27, 2016) indicates project site elevations range from approximately +45 to +49 feet above mean sea level (msl).

Our review of available literature and historical photographs provide a limited site history. Therefore, unknown buried structures (wells, foundations, utility lines, septic systems, etc.) may be present on-site and may be encountered during construction.

SITE GEOLOGY

The *Geologic Map of the Cape Mendocino, Eureka, Garberville, and Southwestern Part of the Hayfork 30 X 60 Minute Quadrangles and Adjacent Offshore Areas, Northern California*,

indicates the project site is underlain by Holocene and Pleistocene-aged non-marine terrace deposits consisting of gravel, sand, silt, and clay. Based on the soils encountered during our on-site investigation, and our knowledge of the project area, it is our opinion the soils underlying the project site are generally consistent with those mapped as non-marine terrace deposits. The distribution of surficial deposits in the vicinity of the project site are shown on the Regional Geologic Map, Figure 2.

SUBSURFACE SOIL CONDITIONS

The exploratory test pits excavated during our on-site investigation exposed artificial fill and Holocene and Pleistocene-aged non-marine terrace deposits. As observed in the test pits, the artificial fill consisted of aggregate base rock and medium dense, silty sand with scattered debris (concrete, bricks) to an approximate maximum depth of 2½ feet below existing ground surface (bgs). As observed in the test pits, the terrace deposits generally consisted of loose to medium dense, poorly-graded sand and medium dense clayey sand to an approximate maximum depth of ten feet bgs. Groundwater was not encountered in the test pits, excavated on October 3, 2019.

Review and interpretation of the CPT data indicates the site is underlain soils with behavior types generally consistent with medium dense to very dense clean sands to silty sands with thin (four to eight inches thick) layers of interbedded medium stiff to stiff silty clay and medium dense sandy silt to an approximate depths of 41 to 43 feet bgs. These soils overlie medium stiff to stiff silty clay to approximate depths of 45 to 48 feet bgs. The clay soils are underlain by medium dense to dense silty sand to sandy silt to the approximate maximum explored depth of 50 feet bgs.

Please refer to Figure 3 for test pit and CPT locations, and Logs of Test Pits, Figures 4 and 5 for further details regarding the soil conditions at a particular location. CPT data is included in this report as Appendix C. Please note that subsurface conditions encountered within the test pits and CPTs are representative of the soil conditions at the time of exploration and at the specific location. It should be expected that soil conditions across the site can and will vary laterally and vertically from those encountered during our investigation.

GROUNDWATER

Groundwater was not encountered within the test pits excavated on October 3, 2019. Historical data from the closest California State Water Resources Control Board (<https://geotracker.waterboards.ca.gov/>) monitoring wells (HCC-1 and HCC-101D), located

near the northwest corner of the existing gravel parking lot, indicate groundwater has been recorded between approximate depths of 9 and 14 feet bgs from August 2000 through September 2019.

Groundwater levels may fluctuate beneath the site depending on the time of year and rainfall amounts. Therefore, groundwater conditions presented in this report may not be representative of those which may be encountered during or subsequent to construction.

CONCLUSIONS

Based on our review of the Kleinfelder report, our subsurface investigation, and knowledge of the proposed development, it is our opinion that the conclusions and recommendations contained in the original *Geotechnical Investigation Report* remain generally applicable for design and construction of the proposed facility, with the following amended conclusions and recommendations. A copy of the Kleinfelder *Geotechnical Investigation Report* is attached to this report as Appendix E.

SHEAR WAVE SEISMIC VELOCITY AND SEISMIC SITE CLASS

Shear wave velocity data was obtained from our seismic CPTs and utilized to determine the average shear wave velocity (ASCE 7-16, Equation 20.4-1). Based on the calculated average shear wave velocity from the CPT's, the project site would fall within the range of Site Class D (ASCE 7-16, Table 20.3-1).

Based on the information provided above, it is our opinion that the soils at this site should be designated as Site Class D in determining seismic design forces for this project in accordance with Section 1613.2 of the 2019 California Building Code (CBC).

SEISMIC DESIGN PARAMETERS

Section 1613A of the 2016/2019 editions of the California Building Code (CBC) reference the American Society of Civil Engineers (ASCE) 7 for seismic design. The following seismic parameters were determined based on the site latitude and longitude using the web interface developed by the Structural Engineers Association of California (SEAOC) and California Office of Statewide Health Planning and Development (OSHPD) (<https://seismicmaps.org/>) to retrieve seismic design data from the public domain computer

program developed by the USGS. The seismic design parameters summarized in the tables on the following page may be used for seismic design depending on which edition of the CBC will be used for design of the proposed improvements.

2016 CBC/ASCE 7-10 Seismic Design Parameters				
Latitude: 40.8029° N Longitude: -124.1609° W	ASCE 7-10 Table/Figure	2016 CBC Table/Figure	Factor/ Coefficient	Value
Short-Period MCE at 0.2s	Figure 22-1	Figure 1613.3.1(1)	S_s	3.06 g
1.0s Period MCE	Figure 22-2	Figure 1613.3.1(2)	S_1	1.20 g
Soil Class	Table 20.3-1	Section 1613.3.2	Site Class	D
Site Coefficient	Table 11.4-1	Table 1613.3.3(1)	F_a	1.00
Site Coefficient	Table 11.4-2	Table 1613.3.3(2)	F_v	1.50
Adjusted MCE Spectral Response Parameters	Equation 11.4-1	Equation 16-37	S_{MS}	3.06 g
	Equation 11.4-2	Equation 16-38	S_{M1}	1.79 g
Design Spectral Acceleration Parameters	Equation 11.4-3	Equation 16-39	S_{DS}	2.04 g
	Equation 11.4-4	Equation 16-40	S_{D1}	1.20 g
Seismic Design Category	Table 11.6-1	Section 1613.3.5(1)	Risk Category I to IV	D
	Table 11.6-2	Section 1613.3.5(2)	Risk Category I to IV	D

MCE – Maximum Considered Earthquake
g – Acceleration due to gravity

The site modified peak ground acceleration, PGA_M , (Equation 11.8-1, ASCE 7-10) for the site is 1.267 g.

The 2019 CBC values provided below may be utilized for design of the proposed residential structures provided the Exceptions defined in Section 11.4.8 are conformed to. If the Exceptions defined in Section 11.4.8 are not conformed to, a site-specific ground motion analysis will be required per ASCE 7-16.

2019 CBC/ASCE 7-16 Seismic Design Parameters				
Latitude: 40.8029° N Longitude: -124.1609° W	ASCE 7-16 Table/Figure	2019 CBC Table/Figure	Factor/ Coefficient	Value
Short-Period MCE at 0.2s	Figure 22-1	Figure 1613.2.1(1)	S_s	2.80 g
1.0s Period MCE	Figure 22-2	Figure 1613.2.1(2)	S_1	1.09 g
Soil Class	Table 20.3-1	Section 1613.2.2	Site Class	D
Site Coefficient	Table 11.4-1	Table 1613.2.3(1)	F_a	1.00
Site Coefficient	Table 11.4-2	Table 1613.2.3(2)	F_v	1.70
Adjusted MCE Spectral Response Parameters	Equation 11.4-1	Equation 16-36	S_{MS}	2.80 g
	Equation 11.4-2	Equation 16-37	S_{M1}	1.85 g
Design Spectral Acceleration Parameters	Equation 11.4-3	Equation 16-38	S_{DS}	1.88 g
	Equation 11.4-4	Equation 16-39	S_{D1}	1.23 g
Seismic Design Category	Table 11.6-1	Section 1613.2.5.1	Risk Category I to III	E
	Table 11.6-2	Section 1613.3.5.1	Risk Category IV	F

MCE – Maximum Considered Earthquake
g – Acceleration due to gravity

The site modified peak ground acceleration, PGA_M , (Equation 11.8-1, ASCE 7-16) for the site is 1.256 g.

FOUNDATION AND SLAB SUPPORT

Based on our field investigation, it is our opinion the on-site, near-surface soils are comprised of artificial fill soils and native soils that possess variable composition, density, and support qualities. In addition, site clearing operations will disturb a majority of the near-surface soils creating variable density and support conditions. Due to higher than normal structural bearing capacities requested by the project Structural Engineer, variable soil density and support conditions, and in order to provide uniform support of foundations, we will recommend over-excavation and re-compaction of artificial fill and native soil as engineered fill within project structural areas, including building pads and exterior concrete flatwork, to promote more uniform support for the planned improvements. Over-excavation depths may vary across the site based on conditions exposed during site preparation and grading.

Based on our field investigation and laboratory test results, it is our opinion that firm, undisturbed native soils and engineered fill that is properly placed and compacted will be capable of supporting the planned building and at-grade structures, provided the following recommendations regarding site preparation, and engineered fill placement and compaction are carefully followed. Specific recommendations for over-excavation are presented in the SITE PREPARATION section of this report.

DRY SAND SEISMIC SETTLEMENT

Dry sand seismic settlement can be evaluated using the method of Pradel (1998). This method is a simplified method based on earlier work by Tokimatsu and Seed (1987) applicable to sands. The upper five feet of on-site soils consist of medium dense, poorly-graded sands and silty sands. Modelling of these soils using the commercially available software program CLiq (v.2.0.6.85) developed by Geologismiki, utilizing CPT data, indicates dry sand seismic-induced settlement of up to approximately 4.2 inches. It should be noted that we will recommend over-excavation and re-compaction of the near-surface soils to a higher density during grading operations to improve support characteristics; thereby, decreasing potential dry sand settlement.

LIQUEFACTION

Liquefaction is a soil strength and stiffness loss phenomenon that typically occurs in loose, saturated cohesionless soils as a result of strong ground shaking during earthquakes. The potential for liquefaction at a site is usually determined based on the results of a subsurface geotechnical investigation (including a 50 foot exploration boring or cone penetration sounding) and the groundwater conditions beneath the site. Hazards to buildings associated with liquefaction include bearing capacity failure, lateral spreading, and differential settlement of soils below foundations, which can contribute to structural damage or collapse. The site is not located within a State Designated Seismic Hazard Zone for liquefaction.

The site is underlain by recent artificial fill soils and Holocene and Pleistocene-aged native terrace deposit soils. As encountered in the test pits, the artificial fill soils generally consisted of medium dense, silty sand with varying quantities of debris. The native terrace deposit soils generally consisted of loose to medium dense, poorly-graded sand and medium dense clayey sand. As encountered in the CPT's, the on-site soils generally consisted of

medium dense to very dense clean sands to silty sands with thin (four to eight inches thick) layers of interbedded medium stiff to stiff silty clay and medium dense sandy silt; medium stiff to stiff silty clay; and medium dense to dense silty sand to sandy silt.

However, groundwater was not encountered within the test pits excavated on October 3, 2019 to an approximate maximum depth of ten feet bgs. Review of available historic information in the project vicinity indicates groundwater has been measured between approximate depths of 9 and 14 feet bgs.

We performed a liquefaction analyses on the data collected from our three CPT soundings using the commercially available software program CLiq (v.2.0.6.85) developed by Geologismiki. The analysis was performed using the NCEER methodology. Input earthquake ground motion for the liquefaction analysis was 1.267 g (PGA_M , 2016/2019 CBC Section 1803A.5.11 for Site Classification D); M8.1 earthquake (USGS Interactive Deaggregations webpage); and, an in-situ depth to groundwater of approximately five feet based on historical groundwater information. A factor of safety (FS) of 1.0 against liquefaction was used in the analyses. Appendix D of this report includes the output files of our liquefaction analyses.

Based on the results of our subsurface exploration and analyses using the CLiq software program, the upper approximately 50 feet contain soils that may be potentially liquefiable and susceptible to seismic settlements. Liquefaction analyses were performed using CPT data. Analysis using the CLiq software program and the current subsurface data indicates estimated maximum total seismic settlements due to a cyclic event range between approximately 1.7 and 2.3 inches using the CPT data. The Liquefaction Potential Index (LPI) values estimated from the analyses range from 11.1 to 15.6 for the CPT data. LPI values range from zero to 100. Iwasaki et al. (1982) suggested that liquefaction effects are low for $0 < LPI < 5$; moderate for $5 < LPI < 15$; and, major for $LPI > 15$. The estimated LPI values from the analyses fall into the high and very high liquefaction risk zone.

Based on the geology of the site, estimated LPI values, and our experience in the area, the total settlement calculated during our liquefaction analysis is considered worst case.

CYCLIC SOFTENING

The soils encountered in our CPT's generally consisted of loose to very dense clean sands to silty sands with thin, interbedded medium stiff silty clay and medium dense sandy silt, stiff

silty clay, and medium dense to dense silty sand to sandy silt to the approximate maximum explored depth of 50 feet bgs. Low strength clays were not encountered; therefore, it is our opinion the potential for cyclic softening occurring beneath the site is low.

PAVEMENT SUBGRADE QUALITY

Laboratory test results indicate the near-surface soils are good quality materials for the support of asphalt concrete pavements. Based on the results of laboratory testing, a Resistance-value of 30 is considered appropriate for design of pavements. Resistance-value test results are attached as Figure A1.

RECOMMENDATIONS

SITE PREPARATION AND OVER-EXCAVATION

Initially the site should be cleared of trees, vegetation, concrete slabs, debris, and other deleterious materials to expose firm and stable soil conditions as identified by our on-site representative. Our review of available literature and historical photographs provide a limited site history. Therefore, unknown buried structures (foundations, septic tanks and lines, etc.) may be present on-site and may be encountered during construction. If encountered, these structures should be removed and the resulting cavities or holes should be backfilled with properly moisture conditioned and compacted engineered fill as described in this report.

Where practical, the clearing should extend a minimum of five feet beyond the limits of the proposed improvement and structural areas of the site. Existing underground utilities, if encountered, located within proposed building pads should be completely removed and/or rerouted as necessary. Utilities located outside the building area should be properly abandoned (i.e., fully grouted provided the abandoned utility is situated at least 2½ feet below the final subgrade level to reduce the potential for localized “hard spots”).

Trees and large brush designated for removal should include the entire root ball and all surface roots larger than ½-inch in diameter. Adequate removal of debris, rubble, and tree roots may require laborers and handpicking to clean the subgrade soils to the satisfaction of our on-site representative.

Depressions resulting from clearing operations and any other loose, disturbed, soft or otherwise unstable materials should be removed to expose a firm, undisturbed soils prior to backfilling with properly placed and compacted engineered fill to restore the areas back to the required grades.

It is essential that our representative be present during clearing operations to verify adequate removal of existing and former structures, as well as trees and roots, and determine the need for over-excavation of disturbed soil areas. It is essential that excavations resulting from clearing operations be left as shallow dish-shaped depressions for proper location and to allow proper access with compaction equipment during grading operations. If clearing and removal of structures takes place without direct observation by the Geotechnical Engineer, deeper cross-ripping and/or over-excavation of the disturbed areas and the building pad or structural areas affected will be required.

Provided MPE is present during clearing operations and the excavations for removal of subsurface elements are left as dish shaped depressions so that our representative can verify adequate and complete removal, pad preparation can proceed as recommended below. If this is not the case and MPE is not present during site clearing operations or if excavations are backfilled without our observation and testing, the entire building pad (building area plus five feet beyond) will require deeper processing or over-excavation and re-compaction.

Building Pad Over-Excavation

Our on-site investigation indicated loose, compressible artificial fill and native soils are present across the project site. All loose, compressible soil within building pads and site structural areas should be over-excavated to expose firm, undisturbed native soil, as determined by our on-site representative. Minimum over-excavation depths of three feet below bottom of footings (or at least 6 feet below lowest adjacent soil grade) are recommended to support the proposed structures. However, deeper over-excavations may be required across the project site where loose soils are encountered. Where adequate space permits, the over-excavations should extend a minimum of five feet horizontally beyond the proposed structure lines, and should include areas of exterior columns, areas supporting exterior flatwork and pavements, or other areas supporting at-grade structures.

MPE should review the final plans to verify the applicability of these recommendations and determine the need for revised recommendations.

The bottom of all over-excavations should be ripped and cross-ripped to a minimum depth of six inches, moisture conditioned to at least the optimum moisture content, and compacted to at least 95 percent of the ASTM D1557 maximum dry density. The compacted subgrades must be in a stable and unyielding condition for proper structural support.

All areas that are to remain at-grade, to receive fill, or obtained by excavation should be scarified to a depth of six inches, uniformly moisture conditioned to achieve at least the optimum moisture condition, and compacted to at least 95 percent of the ASTM D1557 maximum dry density. Grades must be properly compacted and stable. It should be anticipated that some over-excavation and/or stabilization could be needed in these areas, if the soils are wet, soft or unstable at the time of construction.

Compaction operations should be undertaken with a heavy, self-propelled, sheepfoot compactor (Caterpillar CS56 or equivalent size) capable of providing adequate compaction and should be performed in the presence of our representative who will evaluate the performance of the subgrade under compactive load and identify loose or unstable soils that could require additional excavation and/or compaction. Loose, soft, or unstable soils, as identified by our representative in the field, should be cleaned out to firm, undisturbed and stable soils, as determined by our representative, and should be restored to grade with engineered fill compacted in accordance with the recommendations of this report. Difficulty in achieving subgrade compaction or unusual soil instability may be indications of loose fill associated with past subsurface items. Should these conditions exist, the materials should be excavated to check for subsurface structures and the excavations backfilled with engineered fill. We recommend construction bid documents contain a unit price (price per cubic yard) for all excess excavation due to loose, soft, or unsuitable materials and replacement with engineered fill.

ENGINEERED FILL CONSTRUCTION

Engineered fill should be placed in horizontal lifts not exceeding six inches in compacted thickness. Engineered fill should be brought to at least the optimum moisture content and compacted to at least 95 percent of the maximum dry density as determined by ASTM D1557. Additional passes with the compactor shall be added, as required by the Geotechnical Engineer, to achieve a firm, stable and unyielding subgrade condition. Compactive effort should be applied uniformly across the full width of fill construction.

The on-site soils will be suitable for use as engineered fill if the materials are at a workable moisture content and free of rubbish, rubble, debris and concentrations of organics, and have a maximum particle size of three inches or less. Hand picking of exposed roots, rubbish, debris, and over-sized rock should be performed by the Contractor to adequately clear the grades and properly prepare and clear the soils proposed as fill, prior to use. The upper 12 inches of final building pad and exterior flatwork subgrades must consist of approved on-site or imported granular, non-expansive soils.

Imported fill material, if required, should consist of well-graded granular soils or well-graded aggregates with a Plasticity Index of 15 or less, an Expansion Index of 20 or less, and should have no particles greater than three inches in maximum dimension. Clean, open graded gravels (such as crushed rock or pea gravel) and other such materials are not acceptable for fill construction. The contractor also should supply appropriate documentation for imported fill materials indicating the materials are free of known contamination and have corrosion characteristics within acceptable limits. The imported materials should be sampled, tested, and approved before being transported to the project site. Samples should be submitted to the Geotechnical Engineer at least two weeks prior to planned importation to the site.

The upper six inches of final building and structural areas and exterior flatwork subgrades should be scarified, brought to at least the optimum moisture content, and uniformly compacted to not less than 95 percent of the maximum dry density, as determined by ASTM D1557, regardless of whether final grade is completed by excavation, filling, or left at-grade.

The upper six inches of exterior slab subgrades supporting vehicle loadings and pavement subgrades should be scarified, moisture conditioned to at least the optimum moisture content and uniformly compacted to at least 95 percent of the ASTM D1557 maximum dry density, and must be stable under construction traffic prior to placement of aggregate base. Final subgrade processing and compaction should be performed just prior to placement of aggregate base, after construction of underground utilities is complete.

Site preparation should be accomplished in accordance with the recommendations of this section and the Guide Earthwork Specifications provided in Appendix B. It is essential that a representative from our office be present on a nearly full-time basis during site preparation and all grading operations to verify complete removal of undocumented fills and/or unstable soil deposits, to observe the earthwork construction, perform compaction testing and verify compliance with our recommendations and the job specifications.

FOUNDATION DESIGN

We are providing design soil values for the analysis of proposed foundations, and suggested minimums for dimensions, but only from a Geotechnical Engineering perspective. The project Structural Engineer should determine final foundation design width and depth dimensions and reinforcing requirements, based on their specific structural design which should include an appropriate factor of safety applied to the overall design.

Several foundation options were initially considered for the proposed structure and associated improvements. Based on the results of our subsurface investigation and conversations with the project Structural Engineer, we are providing recommendations for conventional shallow foundations extending a minimum of 3 to 3 ½ feet below lowest adjacent soil or pad grade.

Provided the building pad is over-excavated and re-compacted as recommended, the proposed Re-Entry Center structure may be supported upon continuous and/or isolated spread foundations extending a minimum of 24 inches into the prepared building pad or at least 24 inches below lowest adjacent soil grade, whichever is deeper. In addition, the foundations should be underlain by a minimum of three feet of engineered fill. Continuous foundations should be at least 12 inches wide; isolated foundations should be at least 18 inches wide. Foundations must be continuous around the perimeter of the building to help minimize moisture migration beneath the structure.

Foundations so established may be sized for a maximum allowable soil pressure of 3,500 pounds per square foot (psf) for the dead load plus live load condition with a 1/3 increase in allowable soil pressure for consideration of seismic or wind forces. The weight of foundation concrete extending below soil grade may be neglected in sizing computations.

Provided the artificial fill, native soils, and soils disturbed during site clearing are over-excavated and replaced with properly moisture conditioned and re-compacted engineered fill, and foundations are constructed as recommended, we estimate total settlements (*seismic and static*) will be approximately two inches with differential settlements to be about half of the total estimated settlement between adjacent footings, or over the shortest span of the building footprint (subject to change once final plans are developed).

We recommend that all foundations be adequately reinforced to provide structural continuity, resist the anticipated settlements, mitigate cracking and permit spanning of local soil irregularities. As a minimum, continuous foundations should contain *at least* two No. 4

steel reinforcing bars placed one each, near the top and bottom of the foundations. The project designer should determine the need for additional reinforcement, including the need for and design of slab ties and grade beams, based on structural requirements.

Resistance to lateral displacement of shallow foundations may be computed using an allowable friction factor of 0.25 multiplied by the effective vertical load on each foundation. Additional lateral resistance may be achieved using an allowable passive earth pressure against the vertical projection of the foundation equal to an equivalent fluid pressure of 250 psf per foot of depth. These two modes of resistance should not be added unless the frictional component is reduced by 50 percent since mobilization of the passive resistance requires some horizontal movement, effectively reducing the frictional resistance.

Passive resistance should be computed below a depth at which at least five feet of engineered fill or native soil is present in front of the foundation, as measured horizontally from the exterior edge of the foundation.

It is an essential requirement that foundation excavations be observed by a representative of MPE to verify competent and uniform bearing conditions and evaluate the need for any modifications to these recommendations as may be required by specific circumstances. The observations should take place prior to placement of reinforcing steel but following cleaning of the excavations. To account for any re-compaction of foundation bottoms or deepening of foundations that might be required, we suggest bid documents include a unit price for additional compaction or foundation excavation and concrete that may be required.

INTERIOR FLOOR SLAB SUPPORT

Interior concrete slab-on-grade floors can be suitably supported upon the soil subgrade prepared in accordance with the recommendations in this report and maintained in that condition (at or near optimum conditions). Interior concrete slab-on-grade floors should be at least four inches thick and, as a minimum, should be reinforced with chaired No. 3 reinforcing bars on 18-inch center-to-center spacing, located at mid-slab depth. All structural foundation concrete should achieve a minimum compressive strength of 3,000 pounds per square inch (psi) at 28 days. This slab thickness and reinforcement is suggested as a guide "minimum" only; final slab thickness and reinforcement and joint spacing should be determined by the architect or structural engineer based their specific design analysis, anticipated slab loading and the performance expectations. It is emphasized that thicker slabs with greater reinforcing will be needed in areas supporting higher loads or where increased performance is desired. Temporary loads exerted during construction should be

considered in the design of the slab-on-grade floors. Proper and consistent location of the reinforcement at mid-slab is essential to its performance. The risk of uncontrolled shrinkage cracking is increased if the reinforcement is not properly located within the slab.

Floor slabs may be underlain by a layer of free-draining crushed rock, serving as a deterrent to migration of capillary moisture. The crushed rock layer should be at least four inches thick and graded such that 100 percent passes a one-inch sieve and none passes a No. 4 sieve. Additional moisture protection may be provided by placing a plastic water vapor retarder (at least 10-mils thick) directly over the crushed rock. The plastic water vapor retarder should meet or exceed the minimum specifications as outlined in ASTM E1745. Consideration should be given to using a thicker, higher quality membrane for additional moisture protection such as a 15-mil thick vapor barrier or other product. The membrane should be installed so that there are no holes or uncovered areas. All seams should overlap and be sealed with manufacturer-approved tape, continuous at the laps to create vapor tight conditions. All perimeter edges of the membrane, such as pipe penetrations, interior and exterior footings, joints, etc., should be sealed or caulked per manufacturer's recommendations. An optional, thin layer of clean sand above the membrane is acceptable, as an aid to curing of the slab concrete.

Floor slab construction over the past 25 years or more has included placement of a thin layer of sand over the vapor retarder membrane. The intent of the sand is to aid in the proper curing of the slab concrete. However, recent debate over excessive moisture vapor emissions from floor slabs includes concern for water trapped within the sand. As a consequence, we consider the use of the sand layer as optional. The concrete curing benefits should be weighed against efforts to reduce slab moisture vapor transmission.

The recommendations presented above are intended to mitigate any significant soils-related cracking of the slab-on-grade floors. More important to the performance and appearance of a Portland cement concrete slab is the quality of the concrete, the workmanship of the concrete contractor, the curing techniques utilized and the spacing of control joints.

FLOOR SLAB MOISTURE PENETRATION RESISTANCE

It is considered likely that floor slab subgrade soils will become wet to near-saturated at some time during the life of the structures. This is a certainty when slabs are constructed during the wet seasons or when constantly wet ground or poor drainage conditions exist adjacent to structures. For this reason, it should be assumed that all slabs in occupied or living areas, as well as those intended for moisture-sensitive floor coverings or materials,

require protection against moisture or moisture vapor penetration. Standard practice includes the gravel and water vapor retarder as suggested above. However, the gravel and plastic membrane offer only a limited, first-line of defense against soil-related moisture. Recommendations contained in this report concerning foundation and floor slab design are presented as minimum requirements, only from the geotechnical engineering standpoint. It is emphasized that the use of sub-slab crushed rock and water vapor retarder will not "moisture proof" the slab, nor does it assure that slab moisture transmission levels will be low enough to prevent damage to floor coverings or other building components. If increased protection against moisture vapor penetration of slabs is desired, a concrete moisture protection specialist should be consulted. The architect and design team should consider all available measures for slab moisture protection. It is commonly accepted that maintaining the lowest practical water-cement ratio in the slab concrete is an effective way to help reduce future moisture vapor penetration of the completed slabs.

EXTERIOR FLATWORK CONSTRUCTION

Areas to receive exterior concrete flatwork should be scarified, moisture conditioned and properly compacted just prior to placement of concrete. Exterior flatwork may be poured directly upon the properly moisture conditioned and compacted subgrade. Uniform moisture conditioning of subgrade soils is important to reduce the risk of non-uniform moisture withdrawal from the concrete and the possibility of plastic shrinkage cracks. Practices recommended by the Portland Cement Association for proper placement and curing of concrete should be followed during exterior concrete flatwork construction. Some seasonal movement of flatwork should be anticipated. For increased support and performance, the exterior slabs may be underlain by a minimum four inches of Class 2 aggregate compacted to 95 percent relative compaction.

The architect or structural engineer should determine the final thickness, strength, reinforcement, and joint spacing of exterior slab-on-grade concrete; however, we offer the following suggested minimum guidelines. Exterior flatwork should be at least four inches thick and be constructed independent of perimeter building foundations and isolated column foundations by the placement of a layer of felt material between the flatwork and the foundation. Reinforcement should consist of at least heavy duty welded wire fabric (flat sheets), or equivalent steel reinforcing bars, placed mid-depth of the slab. Edges thickened to at least twice the slab thickness may be constructed along the perimeter of exterior slabs.

RETAINING WALL DESIGN

Retaining wall foundations should extend at least 24 inches below soil grade and can be designed utilizing the parameters provided in the FOUNDATION DESIGN section of this report.

Retaining walls that are capable of slight rotation about their base (unrestrained at the top or sides) should be capable of resisting an "active" lateral earth pressure equal to an equivalent fluid pressure of 40 psf per foot of wall backfill for horizontal backfill conditions. Retaining walls that are fixed at the top should be capable of resisting an "at-rest" lateral earth pressure equal to an equivalent fluid pressure of 60 psf per foot for horizontal backfill conditions. For retaining walls with backfill sloped at a gradient no steeper than three 3:1 (horizontal to vertical), add 20 psf per foot of depth to the values provided above.

Retaining walls could experience additional surcharge loading if vehicles are parked, or at-grade foundations are constructed within a 1:1 (horizontal to vertical) projection from the bottom of the retaining wall. Surcharge loading under these circumstances should be evaluated on a case-by-case basis.

Retaining walls should be fully drained to prevent the build-up of hydrostatic pressure behind the wall. Retaining walls should be provided with a drainage blanket (Class 2 permeable material, Caltrans Specification Section 68-2.02F(3)) at least one foot wide extending from the base of wall to within one foot of the top of the wall. The top foot above the drainage layer should consist of compacted on-site materials, unless covered by a slab or pavement. Weep holes or perforated rigid pipe should be provided near the base of the wall to allow drainage of accumulated water. (See Figure 7). Drain pipes, if used, should slope to discharge at no less than a one percent fall to suitable drainage facilities. Open-graded ½-to ¾-inch crushed rock may be used in lieu of the Class 2 permeable material, if the rock and drain pipe are completely enveloped in an approved non-woven geotextile filter fabric.

Structural backfill materials for retaining walls, other than the drainage layer, should consist of on-site or imported granular soils free of significant quantities of rubbish, rubble, organics and rock over three inches in size. Structural backfill should be placed in lifts not exceeding six inches in compacted thickness, and should be mechanically compacted to at least 95percent relative compaction. Final detailing of wall drainage should be provided by the designer of the retaining wall.

We recommend that we review the retaining wall structural plans to verify the applicability of these recommendations and to provide supplemental recommendations, as necessary.

SITE DRAINAGE

Site drainage should be accomplished to provide positive drainage of surface water away from structures and prevent ponding of water adjacent to foundations. The grade adjacent to the structures should be sloped away from foundations at a minimum two percent. Proper control of surface water drainage is essential to the performance of foundations, slabs-on-grade and pavements. We recommend using full-roof gutters, with downspouts from roof drains connected to rigid non-perforated piping directed to an appropriate drainage point away from the structures, or discharging onto paved surfaces leading away from the houses and foundations. Concentrated storm water discharge collected from roof downspouts or surface drains should not be allowed to drain on unprotected slopes adjacent to structures. The ground should be graded to drain positively away from all pavement and building structures. Ponding of surface water should be avoided near foundations and pavements. Landscape berms, if planned, should be constructed in such a manner as to promote drainage away from all buildings.

All excavations should be protected from concentrated storm water run-off to minimize potential erosion. Ponding of surface water or allowing sheet flow of water over any open excavation must be avoided.

PRELIMINARY PAVEMENT DESIGN

Traffic indices (TI's) were not specified for the project; therefore, we are providing a range of typical traffic indices. The project civil engineer should determine the appropriate pavement section based on anticipated traffic conditions and traffic index; we can provide alternative pavement sections based on different TI's, if necessary.

The following preliminary pavement sections presented below have been calculated based on the assumed traffic indices, a Resistance ("R")-value of 30, and the procedures contained within applicable portions of Chapters 600 to 670 of the *California Highway Design Manual*.

Traffic Index	Asphalt Concrete (inches)	Class 2 Aggregate Base (inches)
4.5	2.5	5
6.0	2.5	9
7.0	3.0	12

We emphasize that the performance of pavements is critically dependent upon uniform and adequate compaction of the soil subgrade, as well as all engineered fill and utility trench backfill within the limits of the pavements. Final pavement subgrade preparation, i.e. scarification, moisture conditioning and compaction, should be performed after underground utility construction is completed, just prior to aggregate base placement. The upper six inches of pavement subgrade soils should be compacted to at least 95 percent relative compaction at no less the optimum moisture content and maintained in that condition until covered and protected by aggregate base. Soil subgrades allowed to dry, desiccate or become disturbed must be moisture conditioned and re-compacted prior to placement of aggregate base. All Class 2 aggregate base should be compacted to at least 95 percent of the ASTM D1557 maximum dry density at a moisture content of at least the optimum.

Pavement subgrades must be stable under construction traffic prior to placement of aggregate base. We recommend subgrades be proof-loaded (i.e. wheel-tested using a loaded water truck) prior to aggregate base placement.

In the summer heat, high axle loads coupled with shear stresses induced by sharply turning tire movements can lead to failure in asphalt concrete pavements. Therefore, we recommend that consideration be given to using a Portland cement concrete (PCC) section in areas subjected to concentrated heavy wheel loading, such as entry driveways, and trash enclosures. Our office should review vehicle loading and frequency prior to finalizing sections. As a minimum, the concrete section should consist of at least six inches of PCC underlain by at least six inches of Class 2 aggregate base compacted to not less than 95 percent relative compaction. We recommend PCC slabs be constructed with thickened edges. Edges should be thickened in accordance with ACI 330R. For crack control, if desired, slabs should be reinforced with at least No. 3 reinforcing bars placed on maximum 24-inch centers. Reinforcement must be located at mid-slab depth to be effective. Joint spacing and details should conform to the current Portland Cement Association (PCA) or American Concrete Institute (ACI) guidelines. Portland cement concrete should achieve a minimum compressive strength of 3,500 pounds per square inch at 28 days.

Efficient drainage of all surface water to avoid infiltration and saturation of the supporting aggregate base and subgrade soils is important to pavement performance. Consideration may be given to full-depth curbs where pavements abut landscaped areas to serve as a cut-off against water migrating into the pavement base and subgrade materials. Curbs should extend into the soil subgrade. Weep holes also could be provided at drop inlets, located at the subgrade-base interface, to allow accumulated water to drain from beneath the pavements.

Materials quality and construction of the structural section of the pavements should conform to the applicable provisions of the latest edition of the *Caltrans Standard Specifications*.

EARTHWORK TESTING AND OBSERVATION

Site preparation should be accomplished in accordance with the recommendations of this report and the appended *Guide Earthwork Specifications*. Representatives of Mid Pacific Engineering, Inc. must be present during site preparation and all grading operations to observe and test the fills to verify compliance with our recommendations and the job specifications. In the event that MPE is not retained to provide geotechnical engineering observation and testing services during construction, the Geotechnical Engineer retained to provide this service should indicate in writing that they agree with the recommendations of this report, and prepare supplemental recommendations as necessary.

A final report by the "Geotechnical Engineer" should be prepared upon completion of the project indicating compliance with or deviations from this report and the project plans and specifications. Please be aware that the title Geotechnical Engineer is restricted in the State of California to a Civil Engineer authorized by the State of California to use the title "Geotechnical Engineer."

FUTURE SERVICES

We recommend that our firm be given the opportunity to review the final plans and specifications to verify that the intent of our recommendations has been implemented in those documents.

LIMITATIONS

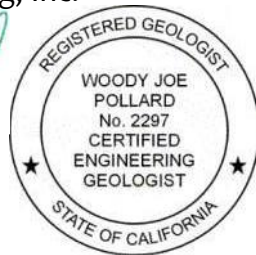
Our recommendations are based upon the information provided regarding the proposed construction, combined with our analysis of site conditions revealed by our subsurface investigation, and our review of referenced reports and letters. We have used our best engineering judgment based upon the information provided and the data generated from our review. This report has been prepared in accordance with generally accepted standards of practice existing in northern California at the time of the report. No warranty, either express or implied, is provided.

If the proposed construction is modified or re-sited; or, if it is found during construction that subsurface conditions differ from those we encountered during our subsurface investigation and as described in the referenced reports, we should be afforded the opportunity to review the new information or changed conditions to determine if our conclusions and recommendations must be modified. Mid Pacific Engineering, Inc., should be retained to review the final plans and specifications to verify that the intent of our recommendations has been implemented in those documents.

We emphasize that this report is applicable only to the proposed construction and the investigated site and should not be utilized for construction on any other site. The conclusions and recommendations of this report are considered valid for a period of two years. If design is not completed and construction has not started within two years of the date of this report, the report must be reviewed and updated, as necessary.

Mid Pacific Engineering, Inc.

Woody Joe Pollard
Project Geologist



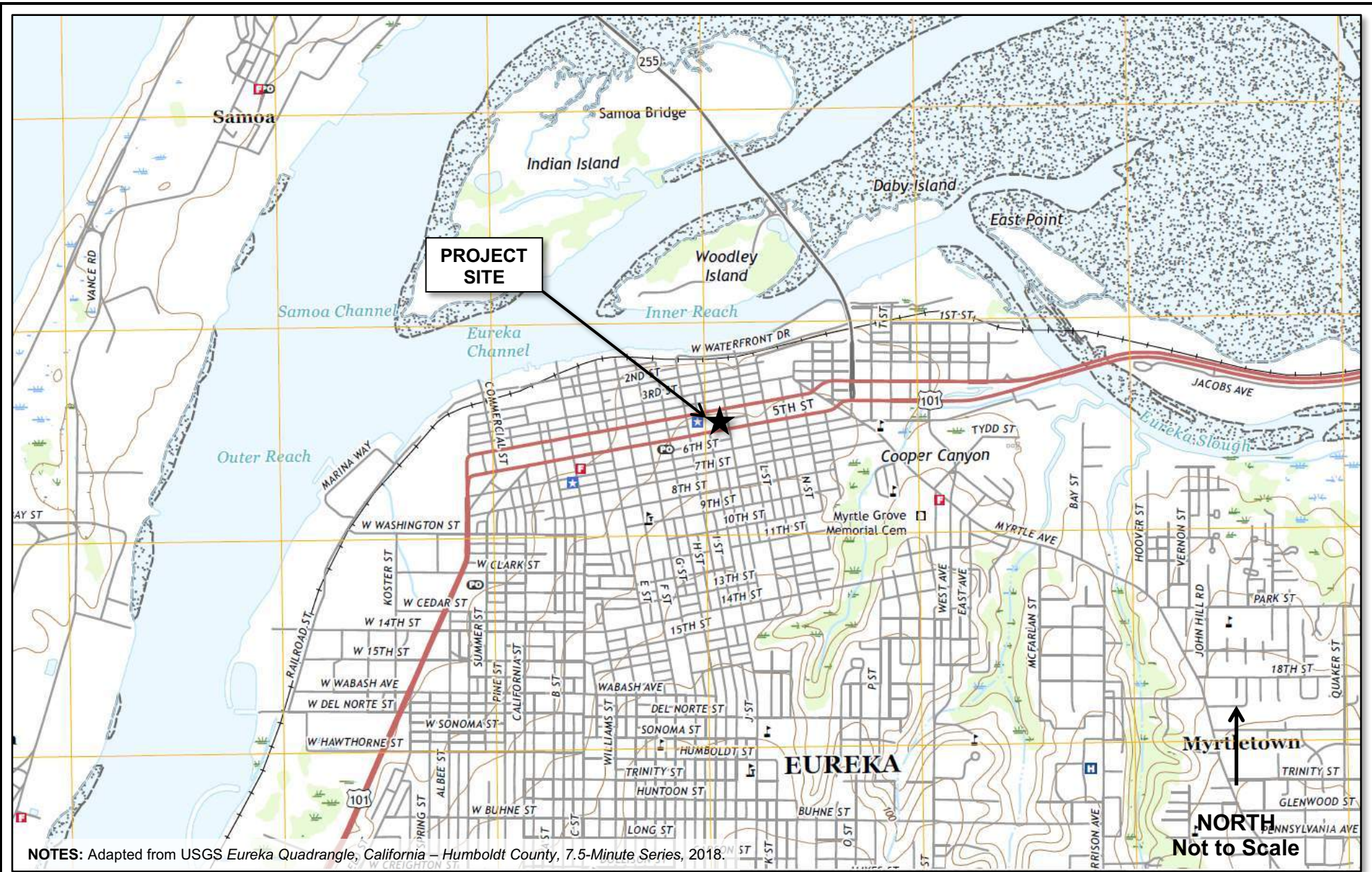
Troy W. Kamisky
Principal Engineer



Daniel C. Smith
Principal Engineer

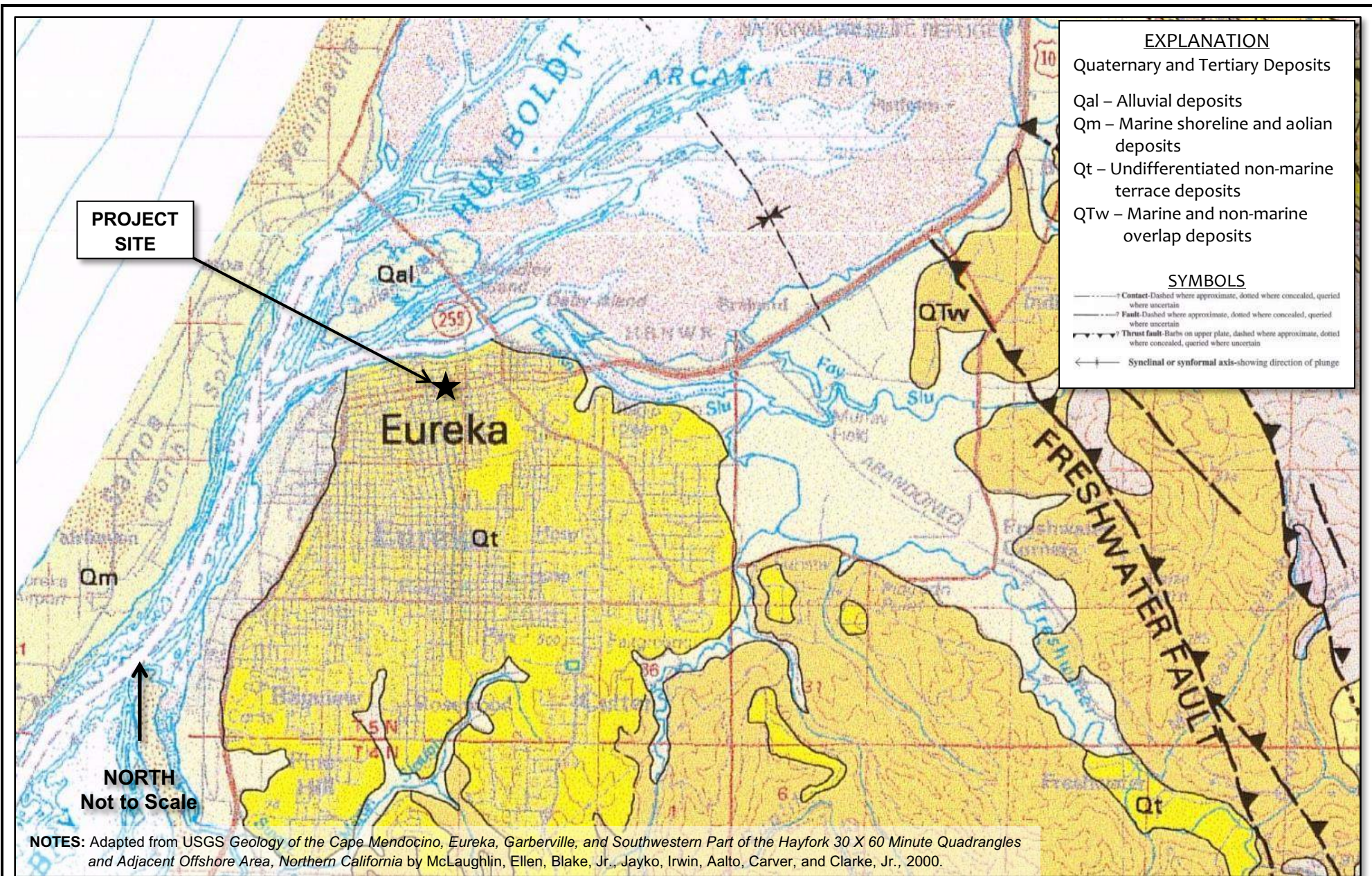


FIGURES



VICINITY MAP
HUMBOLDT COUNTY COMMUNITY CORRECTIONS RE-ENTRY RESOURCE CENTER
 826 4th Street
 Eureka, California

FIGURE 1
 Date: 11/19
 MPE No. 04769-01



REGIONAL GEOLOGIC MAP

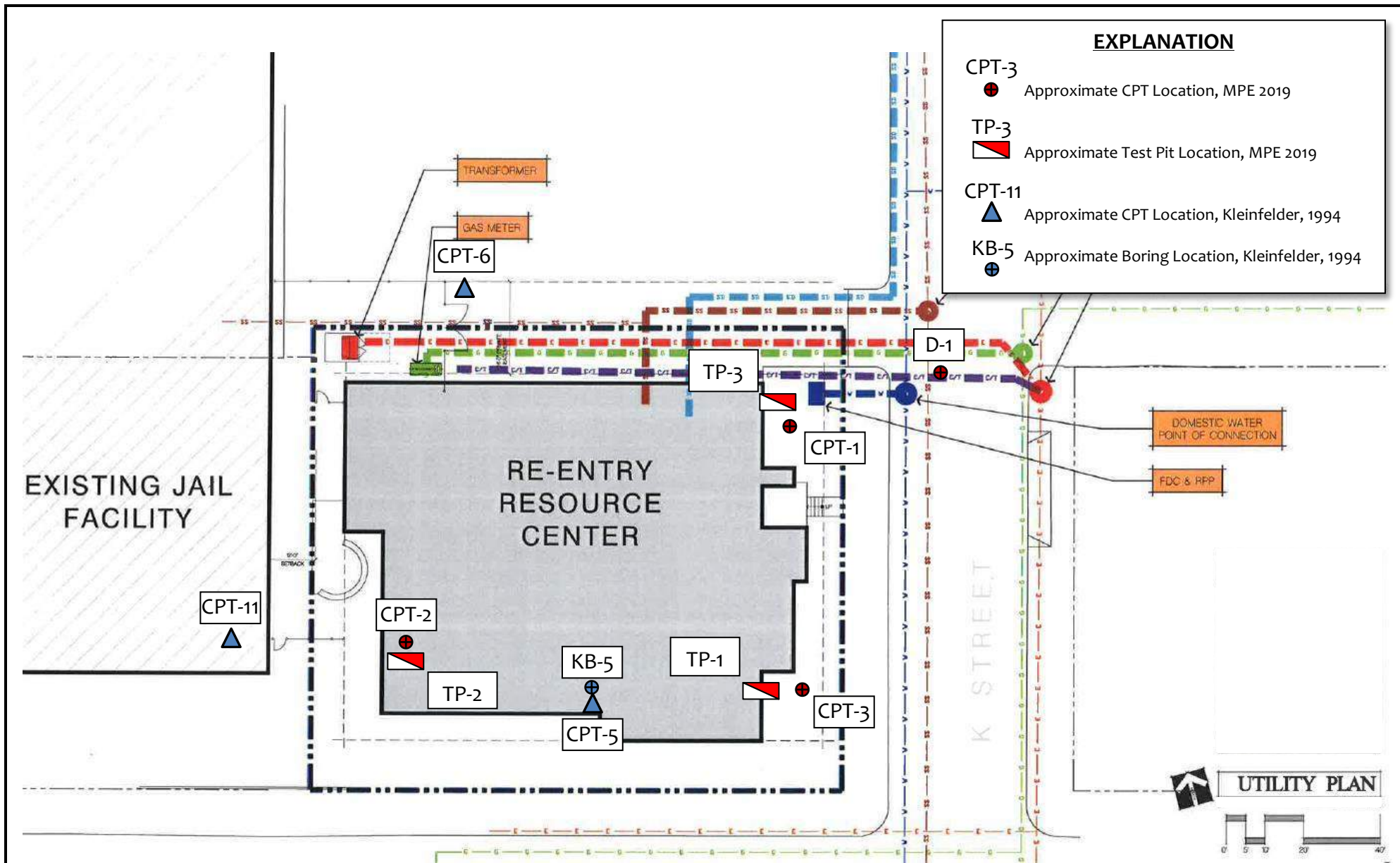
HUMBOLDT COUNTY COMMUNITY CORRECTIONS RE-ENTRY RESOURCE CENTER

826 4th Street
Eureka, California

FIGURE 2

Date: 11/19

MPE No. 04769-01



NOTES: Adapted from Humboldt County Community Corrections Re-Entry Resource Center, Utility Plan, Sheet UTILITY, prepared by Nichols, Melburg & Rossetto, dated March 7, 2019.



SITE INVESTIGATION MAP
HUMBOLDT COUNTY COMMUNITY CORRECTIONS RE-ENTRY RESOURCE CENTER
 826 4th Street
 Eureka, California

FIGURE 3
 Date: 11/19
 MPE No. 04769-01

LOGS OF TEST PITS 1 and 2
Case Backhoe with a 12-inch Bucket
October 3, 2019

Test Pit 1

Depth (bgs)

Artificial Fill

0 – 2” Aggregate baserock.

2” – 1’ Medium dense, slightly moist, dark gray-brown, silty fine sand (SM) with scattered coarse sand and debris (bricks, nails, concrete).

Non- Marine Terrace Deposits

1 – 6’ Medium dense, slightly moist, orange-brown, poorly-graded, fine to medium sand (SP).

6 – 9’ Medium dense, moist, gray-orange-brown, clayey fine sand (SC).

Total depth = 9 feet.

No groundwater encountered.

Backfilled with excavated soil.

Test Pit 2

Depth (bgs)

Artificial Fill

0 – 4” Aggregate baserock.

4” – 2½’ Medium dense, slightly moist, brown and dark brown, silty fine sand (SM) with debris (bricks, nails, concrete).

Non- Marine Terrace Deposits

2½ – 6’ Medium dense, moist, orange-brown, poorly-graded, fine to medium sand (SP).

6 – 10’ Medium dense, moist, gray-orange-brown, clayey fine sand (SC).

Total depth = 10 feet.

No groundwater encountered.

Backfilled with excavated soil.



LOGS OF TEST PITS 1 and 2
HUMBOLDT COUNTY COMMUNITY
CORRECTIONS RE-ENTRY RESOURCE CENTER
826 4th Street
Eureka, California

FIGURE 4

Date: 11/19

MPE No. 04769-01

LOG OF TEST PIT 3
Case Backhoe with a 12-inch Bucket
October 3, 2019

Test Pit 3

Depth (bgs)

Artificial Fill

0 – 2” Aggregate baserock.

Non- Marine Terrace Deposits

2” – 7’ Loose, slightly moist, orange-brown, poorly-graded, fine to medium sand (SP).

7 – 9’ Medium dense, moist, gray-orange-brown, clayey medium sand (SC).

Total depth = 9 feet.

No groundwater encountered.

Backfilled with excavated soil.



LOG OF TEST PIT 3
HUMBOLDT COUNTY COMMUNITY
CORRECTIONS RE-ENTRY RESOURCE CENTER
826 4th Street
Eureka, California

FIGURE 5

Date: 11/19

MPE No. 04769-01

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS		SYMBOL	CODE	TYPICAL NAMES
COARSE GRAINED SOILS (More than 50% of soil > no. 200 sieve size)	GRAVELS (More than 50% of coarse fraction > no. 4 sieve size)	GW		Well graded gravels or gravel - sand mixtures, little or no fines
		GP		Poorly graded gravels or gravel - sand mixtures, little or no fines
		GM		Silty gravels, gravel - sand - silt mixtures
		GC		Clayey gravels, gravel - sand - silt mixtures
	SANDS (50% or more of coarse fraction < no. 4 sieve size)	SW		Well graded sands or gravelly sands, little or no fines
		SP		Poorly graded sands or gravelly sands, little or no fines
		SM		Silty sands, sand - silt mixtures
		SC		Clayey sands, sand clay mixtures
FINE GRAINED SOILS (More than 50% of soil < no. 200 sieve size)	SILTS & CLAYS LL < 50	ML		Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity
		CL		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
		OL		Organic silts and organic silty clays of low plasticity
	SILTS & CLAYS LL ≥ 50	MH		Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
		CH		Inorganic clays of high plasticity, fat clays
		OH		Organic clays of medium to high plasticity, organic silty clays, organic silts
HIGHLY ORGANIC SOILS		Pt		Peat and other highly organic soils
ROCK		RX		Rocks, weathered to fresh
FILL		FILL		Artificially placed fill material

OTHER SYMBOLS

	= Drive Sample: 2-1/2" O.D. Modified California sampler
	= Hand Driven Sample
	= SPT Sampler
	= Initial Water Level
	= Final Water Level
	= Estimated or gradational material change line
	= Observed material change line
Laboratory Tests	PI = Plasticity Index EI = Expansive Index UCC = Unconfined Compression Test TR = Triaxial Compression Test GR = Gradation Analysis (Sieve) K = Permeability Test

GRAIN SIZE CLASSIFICATION

CLASSIFICATION	RANGE OF GRAIN SIZES	
	U.S. Standard Sieve Size	Grain Size in Millimeters
BOULDERS	Above 12"	Above 305
COBBLES	12" to 3"	305 to 76.2
GRAVEL coarse (c) fine (f)	3" to No. 4	76.2 to 4.76
	3" to 3/4"	76.2 to 19.1
	3/4" to No. 4	19.1 to 4.76
SAND coarse (c) Medium (m) fine (f)	No. 4 to No. 200	4.76 to 0.074
	No. 10 to No. 40	4.76 to 2.00
	No. 40 to No. 200	2.00 to 0.420 0.420 to 0.074
SILT & CLAY	Below No. 200	Below 0.074

MPE

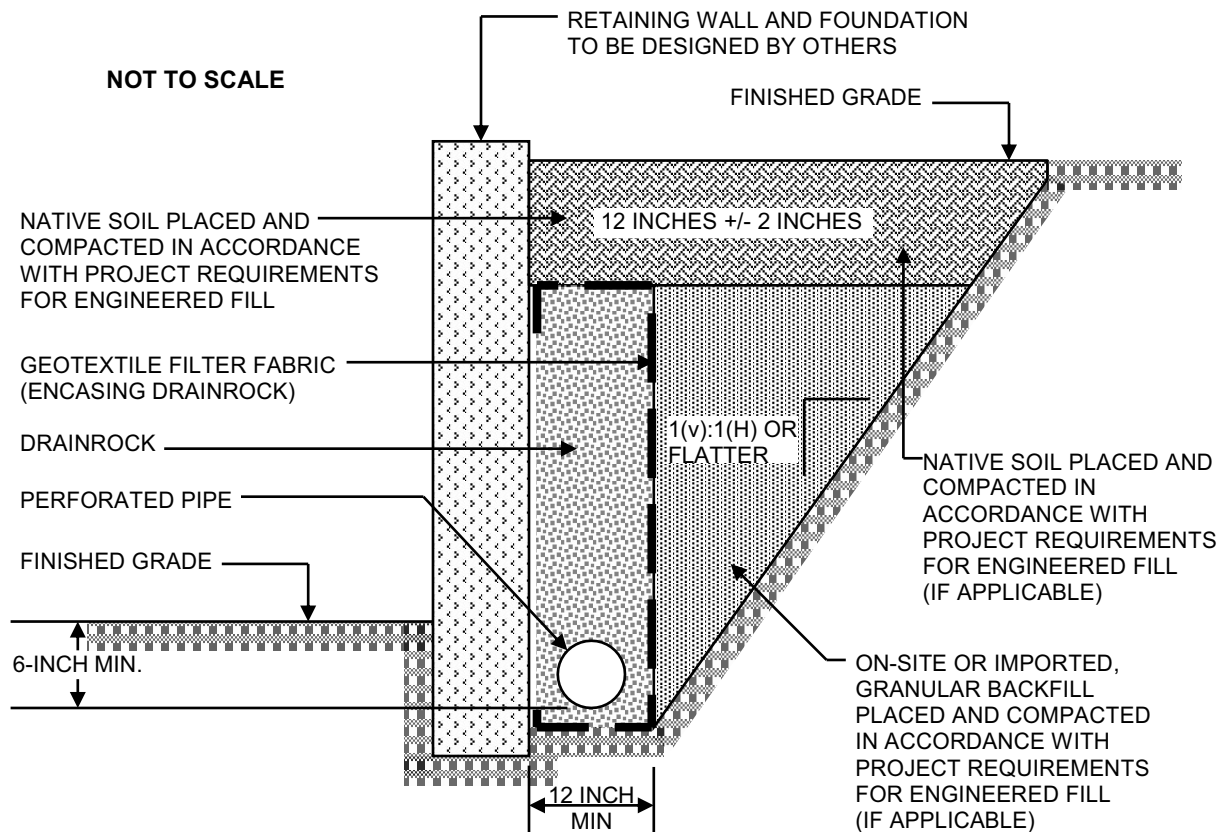
Mid Pacific Engineering, Inc.

UNIFIED SOIL CLASSIFICATION SYSTEM
HUMBOLDT COUNTY COMMUNITY CORRECTIONS RE-ENTRY RESOURCE CENTER
 826 4th Street
 Eureka, California

FIGURE 6

Date: 11/19

MPE No. 04769-01



NOTES:

1. Geotextile filter fabric should consist of Mirafi 140NS or equivalent fabric approved by the project Geotechnical Engineer.
2. Geotextile filter fabric should be stored, handles, and installed in accordance with manufacturer's recommendations.
3. Perforated pipe should be at least 4 inches in diameter and consist of Schedule 40 PVC (holes placed down, no more than ¼-inch in diameter, and spaced a maximum of 12 inches on center).
4. The bottom of all perforated pipes should be placed within 1 to 3 inches of the drainrock. All perforated pipes should be centered (horizontally) within the drainrock.
5. Drainrock should consist of poorly-graded, durable crushed stone, sized such that 100 percent passes the 1-inch sieve and less than 5 percent passes the No. 4 sieve.
6. Solid collector pipe(s) should be at least 4 inches in diameter.
7. All pipe sections should be joined using slip fittings secured with the appropriate adhesive or thread connections.
8. Perforated and solid conduit collector pipes should be sloped a minimum of one percent (1%) to drain.
9. Water collected by the perforated pipe should be directed by solid conduit (of similar type and diameter to perforated) to a sump, ditch, storm drain, or other suitable area for disposal.
10. A prefabricated drainage composite may be substituted for drainrock encased in geotextile filter fabric. Prefabricated drainage composite may consist of Miradrain 6000 or other equivalent composite approved by the project Geotechnical Engineer.
11. Recommendations provided above are for conventional retaining walls consisting of cast-in-place concrete or masonry construction. If other forms of construction (such as crib, reinforced earth, interlocking block, wood, etc.) are to be used, drainage provisions provided above may not be applicable and further review by the Geotechnical Engineer may be required.
12. In general, a wedge of free-draining granular backfill (see above) should be used for walls which retain poor-draining soils (such as clays).



TYPICAL WALL DRAIN DETAIL
HUMBOLDT COUNTY COMMUNITY CORRECTIONS
RE-ENTRY RESOURCE CENTER
 826 4th Street
 Eureka, California

FIGURE 7

Date: 11/19

MPE No. 04769-01

APPENDICES

APPENDIX A

APPENDIX A

A. GENERAL INFORMATION

The performance of a Geotechnical Engineering Update investigation for the proposed Humboldt County Community Corrections Re-Entry Resource Center project, located at 826 4th Street in Eureka, California, was authorized by Mr. Thomas K. Mattson, Public Works Director, on September 17, 2019. Authorization was for an investigation as described in our proposal letter (MPE No 19-0343) of August 5, 2019 sent to Mr. Jake Johnson, Construction Projects Manager, Humboldt County Public Works.

The project Structural Engineer is Nichols, Melburg & Rossetto whose mailing address is 300 Knollcrest Drive, Redding, California 96002; telephone (530) 222-3300, facsimile (530) 222-3538.

In performing this investigation, we referenced the *Humboldt County Community Corrections Re-Entry Resource Center* project plans, prepared by Nichols, Melburg & Rossetto, dated March 7, 2019, *The Geotechnical Investigation Report, Humboldt County, New Courts Facility, Eureka, California*, prepared by Kleinfelder, Inc. (Job No. 41-2467-01/001, dated April 3, 1996), Google Earth images containing the site, the United States Geological Survey (USGS) *7.5-Minute Series Topographic Map Eureka Quadrangle, California – Humboldt County* (2018), and the *Geology of the Cape Mendocino, Eureka, Garberville, and Southwestern Part of the Hayfork 30 X 60 Minute Quadrangles and Adjacent Offshore Area, Northern California* (2000) produced by United States Geological Survey (USGS).

B. FIELD EXPLORATION

On October 3, 2019, three exploratory test pits were excavated at the approximate locations indicated on the Site Investigation Map (Figure 3) utilizing a Case backhoe 4 backhoe equipped with a 12-inch bucket. The test pits were excavated to an approximate maximum depth of ten feet below existing site grades to obtain bulk samples for laboratory testing and to evaluate the condition of the on-site soils. During test pit excavation, the field engineering geologist logged the exposed soil conditions and visually classified the soils. At various depth intervals, bulk soil samples were recovered from the test pits. Collected soil samples were taken to our laboratory for additional classification and selection of samples for testing. The test pits were backfilled with on-site soils upon completion of excavation.

The Logs of Test Pits, Figure 4 and 5, contain descriptions of the soils encountered in each test pit. A Unified Soil Classification System showing the symbols used on the logs are shown on Figure 6.

C. LABORATORY TESTING

One representative bulk sample of anticipated pavement subgrade soils was subjected to Resistance-value ("R") testing in accordance with California Test 301. Results of the R-value test, which were used in the pavement design, are presented on Figure A1.

//

RESISTANCE VALUE TEST RESULTS
(California Test 301)

Material Description: Orange-brown, poorly-graded fine to medium sand (SP)

Location: TP-1 @ 1 – 3'

Specimen No.	Dry Unit Weight (pcf)	Moisture at Compaction (%)	Exudation Pressure (psi)	Expansion Pressure (psi)	R-Value
1	108.1	14.1	130	9	75
2	110.2	12.4	773	0	80
3	109.8	13.3	161	4	76
4	109.6	13.1	552	9	81

Resistance-value at 300 psi = 79



RESISTANCE VALUE TEST RESULTS
HUMBOLDT COUNTY COMMUNITY
CORRECTIONS RE-ENTRY RESOURCE CENTER
826 4th Street
Eureka, California

FIGURE A1

Date: 11/19

MPE No. 04769-01

APPENDIX B

APPENDIX B
GUIDE EARTHWORK SPECIFICATIONS
HUMBOLDT COUNTY COMMUNITY CORRECTIONS RE-ENTRY RESOURCE CENTER

826 4th Street
Eureka, California
MPE No. 04769-01

PART 1: GENERAL

1.1 SCOPE

A. General Description

 This item shall include clearing of all surface and subsurface structures including, undocumented fills, remnants of former construction, pavements, concrete slabs, foundations, surface debris including all trees, shrubbery and associated items; preparation of surfaces to be filled, including over-excavations, filling, spreading, compaction, observation and testing of the fill; and all subsidiary work necessary to complete the grading of the building area to conform with the lines, grades and slopes as shown on the accepted Drawings.

B. Related Work Specified Elsewhere

1. Trenching and backfilling for sanitary sewer system: Section _____.
2. Trenching and backfilling for storm drain system: Section _____.
3. Trenching and backfilling for underground water, natural gas, and electric supplies: Section _____.

C. Geotechnical Engineer

 Where specific reference is made to "Geotechnical Engineer" this designation shall be understood to include either him or his representative.

1.2 PROTECTION

- A. Adequate protection measures shall be provided to protect workers and passers-by at the site. Streets and adjacent property shall be fully protected throughout the operations.
- B. In accordance with generally accepted construction practices, the Contractor shall be solely and completely responsible for working conditions at the job site, including safety of all persons and property during performance of the work. This requirement shall apply continuously and shall not be limited to normal working hours.
- C. Any construction review of the Contractor's performance conducted by the Geotechnical Engineer is not intended to include review of the adequacy of the Contractor's safety measures, in, on or near the construction site.
- D. Adjacent streets and sidewalks shall be kept free of mud, dirt or similar nuisances resulting from earthwork operations.
- E. Surface drainage provisions shall be made during the period of construction in a manner to avoid creating a nuisance to adjacent areas.
- F. The site and adjacent influenced areas shall be watered as required to suppress dust nuisance.

1.3 GEOTECHNICAL REPORT

- A. A Geotechnical Engineering Report Update (MPE No. 04769-01; dated November 29, 2019) has been prepared for this site by Mid Pacific Engineering, Inc., Geotechnical Engineers. A copy is available for review at the office of Mid Pacific Engineering, Inc., 6310 State Highway 273, Anderson, California 96007.
- B. The information contained in this report was obtained for design purposes only. The Contractor is responsible for any conclusions he/she may draw from this report; should the Contractor prefer not to assume such risk, he/she should employ their own experts to analyze available information and/or to

make additional investigations upon which to base their conclusions, all at no cost to the Owner.

1.4 EXISTING SITE CONDITIONS

The Contractor shall be acquainted with all site conditions. If un-shown active utilities are encountered during the work, the Architect shall be promptly notified for instructions. Failure to notify will make the Contractor liable for damage to these utilities arising from Contractor's operations subsequent to the discovery of such un-shown utilities.

1.5 SEASONAL LIMITS

Fill material shall not be placed, spread or rolled during unfavorable weather conditions. When the work is interrupted by heavy rains or snow, fill operations shall not be resumed until field tests indicate that the moisture contents of the subgrade and fill materials are satisfactory.

PART 2: PRODUCTS

2.1 MATERIALS

- A. All fill shall be of approved local materials from required excavations, supplemented by imported fill, if necessary. Approved local materials are defined as local granular soils free from significant quantities of rubble, rubbish and vegetation, and having been tested and approved by the Geotechnical Engineer prior to use. Clods, rocks or hard lumps exceeding three inches (3") in final size shall not be allowed in the upper two feet (2') of any fill supporting pavements and structures. Expansive clays shall not be used within the upper twelve inches (12") of the building pad or exterior flatwork subgrades, or subgrades supporting at-grade structures.
- B. Imported fill materials shall meet the above requirements; shall have plasticity indices not exceeding fifteen (15) when tested in accordance with ASTM D4318 test method; an Expansion Index less than twenty (20) when tested in

accordance with ASTM D4829 test method; an R-value of 30 or greater when tested in accordance with California Test 301; shall be of three-inch (3") maximum particle size; and, shall be approved by the Geotechnical Engineer prior to transportation to the project site.

- C. Import fill shall be clean of contamination with appropriate documentation and shall have corrosion characteristics within acceptable limits. All imported materials shall be sampled, tested and approved by the Geotechnical Engineer prior to being transported to the site.
- D. Asphalt concrete, aggregate base, aggregate subbase, and other paving products shall comply with the appropriate provisions of the *State of California (Caltrans) Standard Specifications*, latest editions.

PART 3: EXECUTION

3.1 LAYOUT AND PREPARATION

Lay out all work, establish grades, locate existing underground utilities, set markers and stakes, set up and maintain barricades and protection of utilities--all prior to beginning actual earthwork operations.

3.2 CLEARING, GRUBBING AND PREPARING BUILDING PADS AND PAVEMENT AREAS

- A. The site shall be cleared of existing structures designated for removal including but not limited to septic tanks and leach fields, concrete slabs, foundations, existing asphalt concrete, concrete pavements, utilities to be relocated or abandoned including backfill, demolition debris, rubbish, rubble, and other unsuitable materials. Exposed remnants, rubble and debris shall be removed from the subgrades. Hand picking of exposed roots, rubble and debris shall be performed by the Contractor to adequately clear the grades. Subsurface utilities to be relocated or abandoned shall be removed from within and to at least five feet beyond the perimeter of the proposed structural areas; utilities located outside the building area should be properly abandoned (i.e., fully grouted provided the abandoned utility is situated at

least 2½ feet below the final subgrade level to reduce the potential for localized “hard spots”). Excavations and depressions resulting from the removal of such items, as well as any existing excavations or loose soil deposits, as determined by the Geotechnical Engineer, shall be cleaned out to firm, undisturbed soil and backfilled with suitable materials in accordance with these specifications.

- B. Following site clearing operations, over- excavation shall be performed to the depths and lateral extents as recommended in the Geotechnical Engineering Report. Hand picking and/or screening of roots, rubble and debris shall be performed by the Contractor to adequately clear the soils proposed for use in engineered fill construction.
- C. Exposed subgrades shall be scarified to a minimum depth of six (6") inches as recommended in the Geotechnical Engineering Report and until the surface is free from ruts, hummocks or other uneven features which would tend to prevent uniform compaction by the selected equipment.
- D. Subgrade preparation and compaction shall extend at least five feet (5') beyond the proposed structure or fill boundary lines, or as required by the Geotechnical Engineer based on the exposed soil and site conditions.
- E. When the moisture content of the subgrade is below that required to achieve the specified density, and that minimum content recommended in the geotechnical report, water shall be added until the proper moisture content is achieved.
- F. When the moisture content of the subgrade is too high to permit the specified compaction to be achieved, the subgrade shall be aerated by blading or other methods until the moisture content is satisfactory for compaction.
- G. After the foundations for fill have been cleared, plowed or scarified, they shall be disced or bladed until uniform and free from large clods, brought to the proper moisture content and compacted to not less than ninety percent (90%)

of the maximum dry density as determined by the ASTM D1557-91 Compaction Test. Soils compaction shall be performed using a heavy, self-propelled sheepsfoot compactor (Caterpillar CS56B or equivalent size). Compaction operations shall be performed in the presence of the Geotechnical Engineer who will evaluate the performance of the materials under compactive load. Wet, soft or unstable soil deposits, as determined by the Geotechnical Engineer, shall be excavated to depths that expose a firm base and grades restored with engineered fill in accordance with these specifications.

3.3 PLACING, SPREADING AND COMPACTING FILL MATERIAL

- A. Engineered fills shall be placed in layers which when compacted shall not exceed six inches (6") in thickness. Each layer shall be spread evenly and shall be thoroughly mixed during the spreading to promote uniformity of material in each layer.
- B. When the moisture content of the fill material is below that required to achieve the specified density, and that minimum content recommended in the geotechnical report, water shall be added until the proper moisture content is achieved.
- C. When the moisture content of the fill material is too high to permit the specified degree of compaction to be achieved, the fill material shall be aerated by blading or other methods until the moisture content is satisfactory.
- D. After each layer has been placed, mixed and spread evenly, soils shall be thoroughly compacted to at least ninety percent (90%) of the ASTM D1557 maximum dry density. Soils compaction shall be performed using a heavy, self-propelled sheepsfoot compactor, to the satisfaction of our on-site representative. Each layer shall be compacted over its entire area until the desired density has been obtained. Fills deeper than five feet (5') shall be

compacted to at least ninety-five percent (95%) of the ASTM D1557 maximum dry density.

- E. Fills placed on or adjacent to sloping ground or where fill slopes are to be constructed shall begin with a base key as required in the Geotechnical Engineering Report. Fills placed on or adjacent to existing slopes, or excavation slopes for over- excavation, shall be properly benched into the side slope, as required by the Geotechnical Engineering Report and as recommended by the Geotechnical Engineer at the time of construction.
- F. The filling operations shall be continued until the fills have been brought to the finished slopes and grades as shown on the accepted Drawings.

3.4 FINAL SUBGRADE PREPARATION

- A. The upper twelve inches (12") of final building pad subgrade and subgrades supporting exterior concrete flatwork or at-grade structures shall consist of approved on-site or imported granular, non-expansive soils or aggregates placed and compacted as engineered fill. Final building pad and flatwork subgrades slabs shall be brought to a uniform moisture content of at least the optimum, and shall be uniformly compacted to at least ninety percent (90%) relative compaction.
- B. The upper six inches (6") of final pavement subgrades and exterior slabs subgrades supporting vehicular traffic shall be brought to a uniform moisture content of at least the optimum moisture content and shall be uniformly compacted to at least ninety-five percent (95%) relative compaction, regardless of whether final subgrade elevations are attained by filling, excavation, or are left at existing grades. Pavement subgrades shall be proof-rolled in the presence of the Geotechnical Engineer prior to placement of aggregate base and shall be stable under construction equipment traffic.

3.5 TRENCH BACKFILL

Utility trench backfill shall be placed in lifts of no more than six inches (6") in compacted thickness. Each lift shall be compacted to at least ninety percent (90%) compaction, as defined by ASTM D1557. The upper six inches (6") of trench backfill supporting pavement sections shall be compacted to at least ninety-five percent (95%) relative compaction. The upper twelve inches (12") of trench backfill shall match the materials used to construct final building pad subgrade and subgrades supporting exterior concrete flatwork or at-grade structures.

3.6 TESTING AND OBSERVATION

- A. Grading operations shall be observed by the Geotechnical Engineer, serving as the representative of the Owner.
- B. Field density tests shall be made by the Geotechnical Engineer after compaction of each layer of fill. Additional layers of fill shall not be spread until the field density tests indicate that the minimum specified density has been obtained.
- C. Earthwork shall not be performed without the notification or approval of the Geotechnical Engineer. The Contractor shall notify the Geotechnical Engineer at least two (2) working days prior to commencement of any aspect of the site earthwork.
- D. If the Contractor should fail to meet the technical or design requirements embodied in this document and on the applicable plans, the Contractor shall make the necessary readjustments until all work is deemed satisfactory, as determined by the Geotechnical Engineer and the Project Design Engineer. No deviation from the specifications shall be made except upon written approval of the Geotechnical Engineer or Project Design Engineer.

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APPENDIX C

Humboldt County CCRC

Project ID: Mid Pacific Engineering
Data File: SDF(916).cpt
CPT Date: 10/3/2019 8:42:07 AM
GW During Test: 13 ft

Page: 2
Sounding ID: CPT-01
Project No: 04769-01
Cone/Rig: DDG1489

Table with columns: Depth, qc, qcln, qinc, qt, Slv pore, Frct, Mat, Material Behavior, Unit Wght, Qc, SPT, SPT, SPT, Rel, Ftn, Und, OCR, Fin, D50, Ic, Nk. Rows contain detailed test data for various depths from 15.58 to 30.84 feet.

* Indicates the parameter was calculated using the normalized point stress. The parameters listed above were determined using empirical correlations. A Professional Engineer must determine their suitability for analysis and design.

Humboldt County CCRC

Project ID: Mid Pacific Engineering
Data File: SDF(916).cpt
CPT Date: 10/3/2019 8:42:07 AM
GW During Test: 13 ft

Page: 3
Sounding ID: CPT-01
Project No: 04769-01
Cone/Rig: DDG1489

Table with columns: Depth ft, qc PS, qcln PS, qincn PS, qt PS, Slv Stss tsf, pore prss, Frct % Ratio, Mat Typ, Material Behavior, Unit Wght pcf, Qc N, SPT R-N1 60%, SPT R-N 60%, SPT IcN1 60%, Rel Den %, Ftn Deg, Und Shr, OCR, Fin Ic, D50 mm, Ic SBT, Nk Indx. Rows contain detailed test data for various soil samples.

* Indicates the parameter was calculated using the normalized point stress.
The parameters listed above were determined using empirical correlations.
A Professional Engineer must determine their suitability for analysis and design.

Humboldt County CCRC

Project ID: Mid Pacific Engineering
 Data File: SDF(916).cpt
 CPT Date: 10/3/2019 8:42:07 AM
 GW During Test: 13 ft

Page: 4
 Sounding ID: CPT-01
 Project No: 04769-01
 Cone/Rig: DDG1489

Depth ft	qc PS	* qc1n PS	* q1ncs PS	* qt PS	* Slv Stss	* pore prss	* Frct Rato	* Mat Typ	* Material Behavior Description	* Unit Wght pcf	* Qc to N	* SPT R-N1 60%	* SPT R-N 60%	* SPT IcN1 60%	* Rel Den	* Ftn Ang	* Und Shr	* OCR	* Fin Ic	* D50 mm	* Ic SBT	* Nk Indx
46.43	269.3	194.8	219.7	269.2	4.0	-2.3	1.5	6	clean SAND to silty SAND	125	5.0	39	54	36	89	43	-	-	9	0.350	1.83	16
46.59	241.9	174.7	217.7	241.8	4.7	-2.3	2.0	6	clean SAND to silty SAND	125	5.0	35	48	34	85	42	-	-	12	0.350	1.96	16
46.75	265.1	191.2	233.2	265.0	5.2	-1.8	2.0	6	clean SAND to silty SAND	125	5.0	38	53	37	88	42	-	-	11	0.350	1.93	16
46.92	339.0	244.2	265.0	339.0	5.1	0.9	1.5	6	clean SAND to silty SAND	125	5.0	49	68	44	95	44	-	-	7	0.350	1.77	16
47.08	453.6	326.3	326.3	453.6	4.5	0.6	1.0	6	clean SAND to silty SAND	125	5.0	65	91	55	95	45	-	-	5	0.350	1.55	16
47.25	516.1	370.8	370.8	516.2	4.4	0.6	0.9	6	clean SAND to silty SAND	125	5.0	74	100	60	95	46	-	-	5	0.350	1.46	16
47.41	522.0	374.5	374.5	522.0	3.6	0.5	0.7	6	clean SAND to silty SAND	125	5.0	75	100	59	95	46	-	-	5	0.350	1.39	16
47.57	503.5	360.7	360.7	503.5	3.6	0.3	0.7	6	clean SAND to silty SAND	125	5.0	72	100	58	95	46	-	-	5	0.350	1.41	16
47.74	469.1	335.6	335.6	469.1	3.8	-0.6	0.8	6	clean SAND to silty SAND	125	5.0	67	94	55	95	45	-	-	5	0.350	1.48	16
47.90	382.0	272.9	272.9	382.0	4.3	-0.3	1.1	6	clean SAND to silty SAND	125	5.0	55	76	47	95	44	-	-	5	0.350	1.65	16
48.07	419.3	299.1	304.2	419.2	5.5	-1.0	1.3	6	clean SAND to silty SAND	125	5.0	60	84	52	95	45	-	-	6	0.350	1.67	16
48.23	410.5	292.5	311.2	410.5	6.4	-1.8	1.6	6	clean SAND to silty SAND	125	5.0	58	82	52	95	45	-	-	7	0.350	1.74	16
48.39	446.1	317.4	323.9	446.1	6.2	-2.1	1.4	6	clean SAND to silty SAND	125	5.0	63	89	55	95	45	-	-	6	0.350	1.67	16
48.56	459.3	326.4	326.4	459.3	5.3	-1.2	1.2	6	clean SAND to silty SAND	125	5.0	65	92	56	95	45	-	-	5	0.350	1.61	16
48.72	419.8	297.8	297.8	419.7	4.8	-2.1	1.1	6	clean SAND to silty SAND	125	5.0	60	84	51	95	45	-	-	5	0.350	1.62	16
48.89	365.3	258.8	273.8	365.2	5.1	-2.0	1.4	6	clean SAND to silty SAND	125	5.0	52	73	46	95	44	-	-	7	0.350	1.73	16
49.05	275.3	194.8	219.6	275.3	4.0	-1.9	1.5	6	clean SAND to silty SAND	125	5.0	39	55	36	89	42	-	-	9	0.350	1.83	16
49.22	240.0	169.6	199.1	239.9	3.7	-2.0	1.6	6	clean SAND to silty SAND	125	5.0	34	48	32	84	42	-	-	10	0.350	1.88	16
49.38	329.5	232.5	238.5	329.6	3.6	0.9	1.1	6	clean SAND to silty SAND	125	5.0	47	66	41	95	43	-	-	6	0.350	1.68	16

* Indicates the parameter was calculated using the normalized point stress.
 The parameters listed above were determined using empirical correlations.
 A Professional Engineer must determine their suitability for analysis and design.

Middle Earth Geo Testing

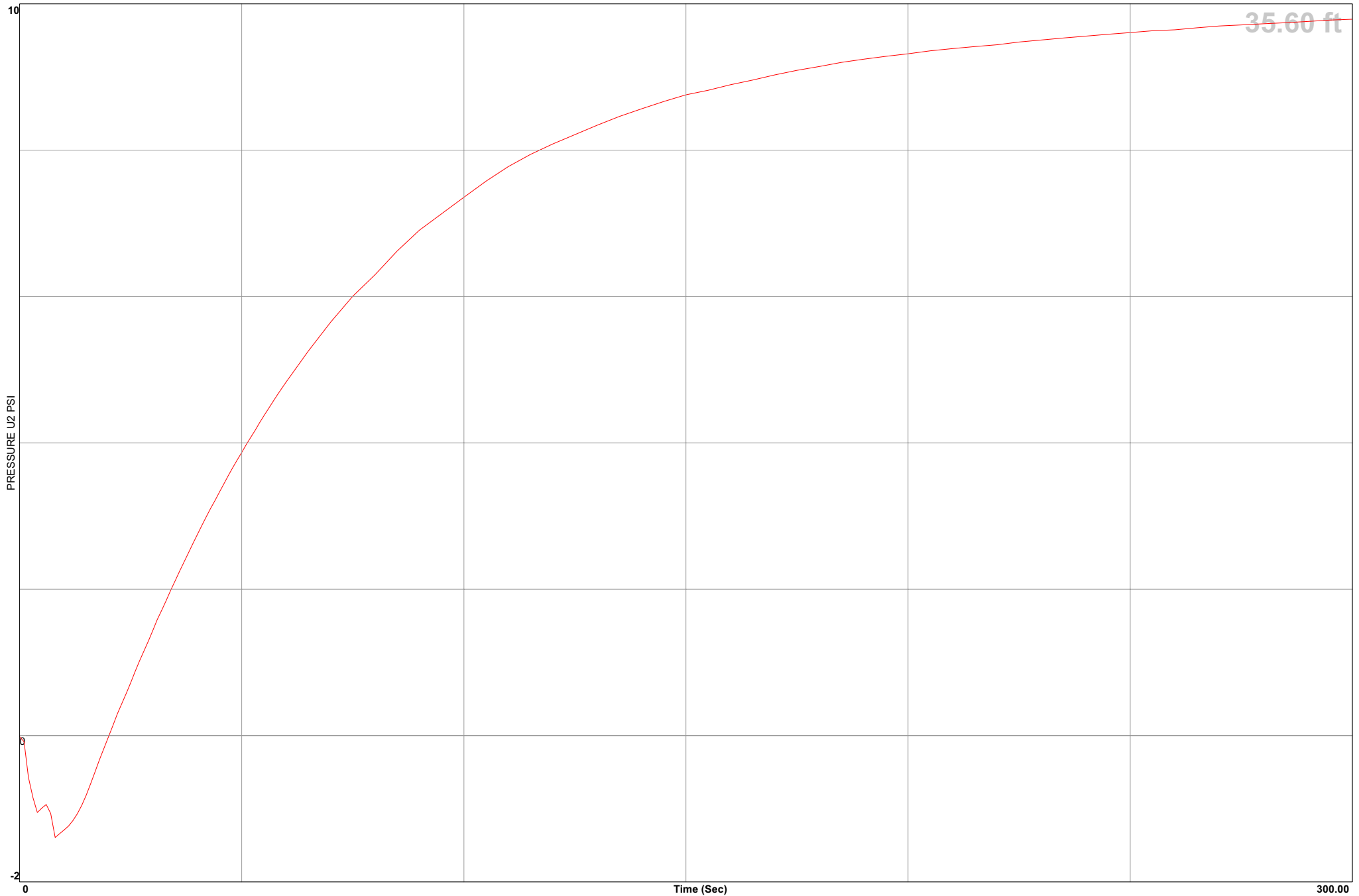


Mid Pacific Engineering

Location Humboldt County CCRC
Job Number 04769-01
Hole Number CPT-01
Equilized Pressure 9.8

Operator BH
Cone Number DDG1489
Date and Time 10/3/2019 8:42:07 AM
EST GW Depth During Test 12.9

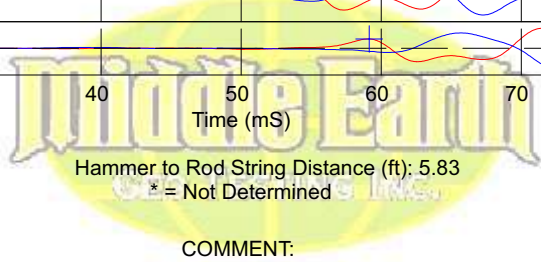
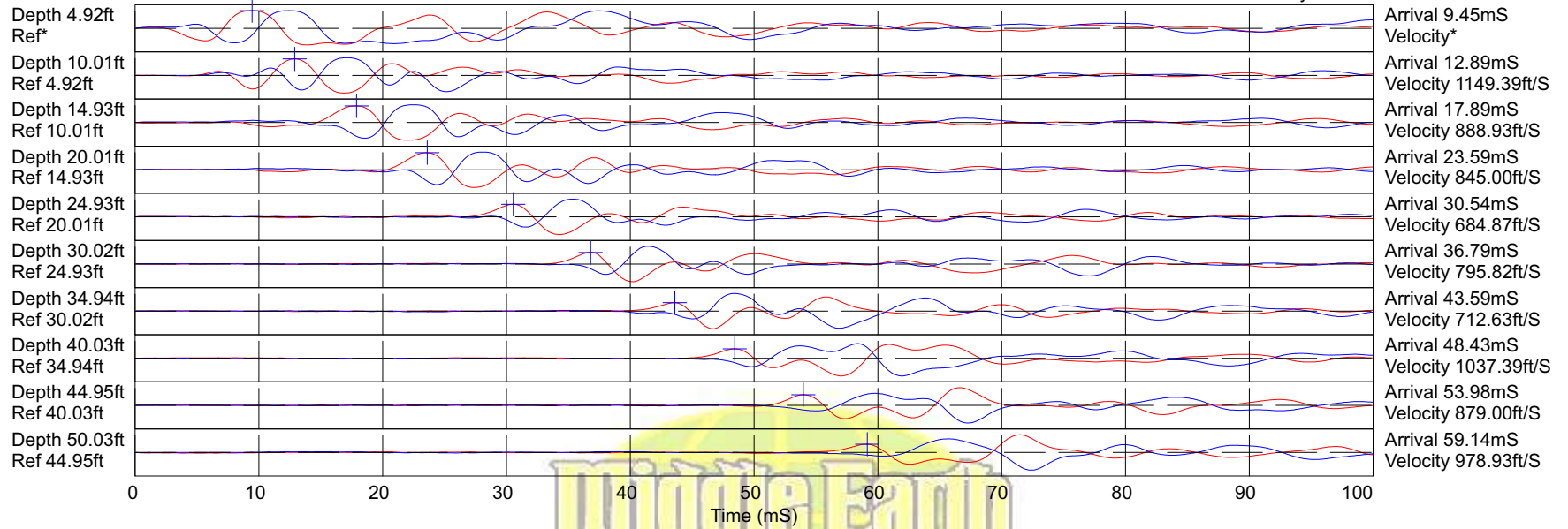
GPS _____



CPT-01

Mid Pacific Engineering

Humboldt County CCRC



Hammer to Rod String Distance (ft): 5.83

* = Not Determined

COMMENT:



Mid Pacific Engineering

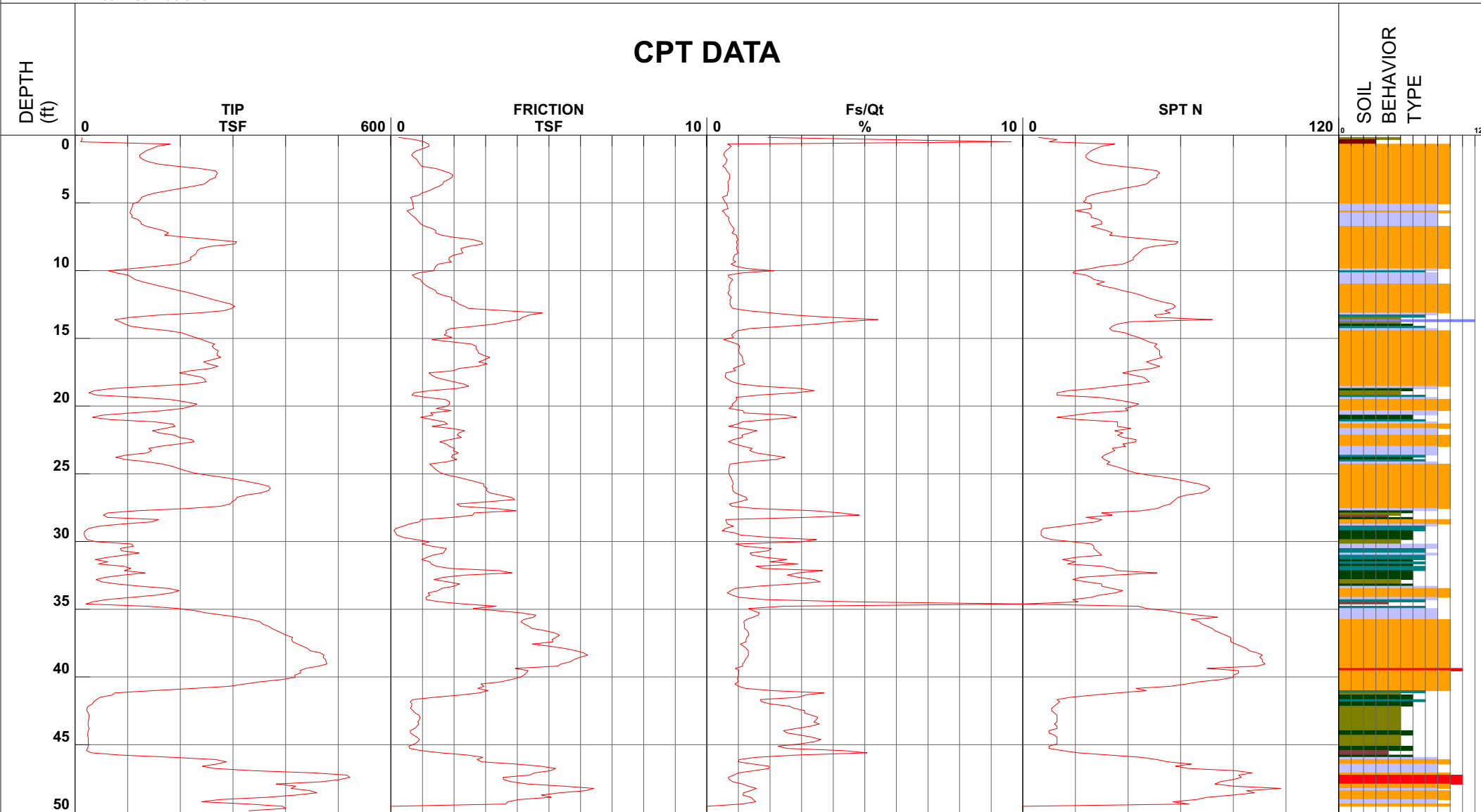
Project Humboldt County CCRC
 Job Number 04769-01
 Hole Number CPT-01
 EST GW Depth During Test

Operator BH
 Cone Number DDG1489
 Date and Time 10/3/2019 8:42:07 AM
 12.90 ft

Filename SDF(916).cpt
 GPS _____
 Maximum Depth 49.87 ft

Net Area Ratio .8

CPT DATA



- | | | | |
|------------------------------|---------------------------------|--------------------------------|------------------------------------|
| ■ 1 - sensitive fine grained | ■ 4 - silty clay to clay | ■ 7 - silty sand to sandy silt | ■ 10 - gravelly sand to sand |
| ■ 2 - organic material | ■ 5 - clayey silt to silty clay | ■ 8 - sand to silty sand | ■ 11 - very stiff fine grained (*) |
| ■ 3 - clay | ■ 6 - sandy silt to clayey silt | ■ 9 - sand | ■ 12 - sand to clayey sand (*) |

Cone Size 10cm squared

S*Soil behavior type and SPT based on data from UBC-1983

Humboldt County CCRC

Project ID: Mid Pacific Engineering
Data File: SDF(918).cpt
CPT Date: 10/3/2019 11:31:52 AM
GW During Test: 13 ft

Page: 2
Sounding ID: CPT-02
Project No: 04769-01
Cone/Rig: DDG1489

Table with columns: Depth, qc, qcln, qinc, qt, Slv, pore, Frct, Mat, Material, Unit, Qc, SPT, SPT, SPT, Rel, Ftn, Und, OCR, Fin, D50, Ic, Nk. Rows contain detailed test data for each depth interval.

* Indicates the parameter was calculated using the normalized point stress. The parameters listed above were determined using empirical correlations. A Professional Engineer must determine their suitability for analysis and design.

Middle Earth Geo Testing

Humboldt County CCRC

Project ID: Mid Pacific Engineering
 Data File: SDF(918).cpt
 CPT Date: 10/3/2019 11:31:52 AM
 GW During Test: 13 ft

Page: 4
 Sounding ID: CPT-02
 Project No: 04769-01
 Cone/Rig: DDG1489

Depth	qc	qcln	q1ncs	qt	Slv	pore	Frct	Mat	Material	Unit	Qc	SPT	SPT	SPT	Rel	Ftn	Und	OCR	Fin	D50	Ic	Nk
ft	tsf	-	-	tsf	tsf (psi)		%	Zon	Description	pcf	N	60%	60%	60%	%	deg	tsf	-	%	mm	SBT	Indx
46.43	24.4	13.5	-	27.2	0.5 139.6	2.5	3	silty	CLAY to CLAY	115	1.5	9	16	4	-	-	1.6	3.9	51	0.005	2.89	15
46.59	23.6	13.0	-	26.3	0.5 137.5	2.4	3	silty	CLAY to CLAY	115	1.5	9	16	4	-	-	1.5	3.8	52	0.005	2.89	15
46.75	22.3	12.2	-	25.2	0.5 148.9	2.3	3	silty	CLAY to CLAY	115	1.5	8	15	4	-	-	1.4	3.5	53	0.005	2.91	15
46.92	22.3	12.2	-	25.3	0.4 149.3	2.3	3	silty	CLAY to CLAY	115	1.5	8	15	4	-	-	1.4	3.5	53	0.005	2.91	15
47.08	22.9	12.5	-	25.8	0.4 147.9	2.1	4	clay	SILT to silty CLAY	115	2.0	6	11	4	-	-	1.5	3.6	51	0.070	2.88	15
47.25	21.3	11.6	-	24.2	0.4 147.8	2.2	3	silty	CLAY to CLAY	115	1.5	8	14	4	-	-	1.4	3.3	53	0.005	2.92	15
47.41	20.2	11.0	-	23.1	0.4 148.1	2.1	3	silty	CLAY to CLAY	115	1.5	7	13	3	-	-	1.3	3.1	54	0.005	2.93	15
47.57	19.1	10.3	-	22.0	0.3 150.2	2.1	3	silty	CLAY to CLAY	115	1.5	7	13	3	-	-	1.2	2.9	56	0.005	2.96	15
47.74	18.2	9.9	-	21.1	0.3 144.6	2.2	3	silty	CLAY to CLAY	115	1.5	7	12	3	-	-	1.2	2.7	58	0.005	2.99	15
47.90	17.5	9.4	-	20.3	0.4 145.3	2.9	3	silty	CLAY to CLAY	115	1.5	6	12	3	-	-	1.1	2.6	64	0.005	3.08	15
48.07	17.5	9.4	-	20.4	0.7 144.2	5.1	3	silty	CLAY to CLAY	115	1.5	6	12	3	-	-	1.1	2.6	74	0.005	3.22	15
48.23	18.3	9.8	-	21.4	1.5 155.7	9.6	3	silty	CLAY to CLAY	115	1.5	7	12	4	-	-	1.2	2.7	87	0.005	3.37	15
48.39	63.3	33.9	-	66.6	2.5 169.2	4.1	4	clay	SILT to silty CLAY	115	2.0	17	32	9	-	-	4.3	9.9	40	0.070	2.68	15
48.56	156.9	111.4	163.0	157.2	3.2 12.2	2.1	5	silty	SAND to sandy SILT	120	4.0	28	39	23	71	40	-	-	16	0.200	2.10	16
48.72	164.7	116.8	178.7	164.6	4.0 -1.8	2.4	5	silty	SAND to sandy SILT	120	4.0	29	41	24	72	40	-	-	17	0.200	2.14	16
48.89	187.0	132.4	203.2	187.0	5.0 -1.6	2.7	5	silty	SAND to sandy SILT	120	4.0	33	47	27	76	40	-	-	17	0.200	2.14	16
49.05	156.1	110.4	187.3	156.1	4.4 -1.8	2.9	5	silty	SAND to sandy SILT	120	4.0	28	39	24	70	39	-	-	19	0.200	2.21	16
49.22	153.3	108.3	162.4	153.3	3.3 -0.9	2.2	5	silty	SAND to sandy SILT	120	4.0	27	38	22	70	39	-	-	17	0.200	2.12	16
49.38	199.1	140.5	177.3	199.1	3.4 -0.3	1.7	6	clean	SAND to silty SAND	125	5.0	28	40	27	78	41	-	-	12	0.350	1.97	16
49.54	304.4	214.5	221.6	304.4	3.2 0.3	1.1	6	clean	SAND to silty SAND	125	5.0	43	61	38	92	43	-	-	6	0.350	1.69	16

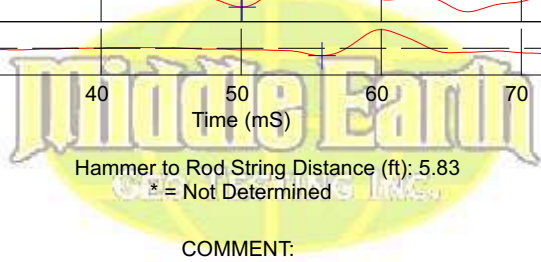
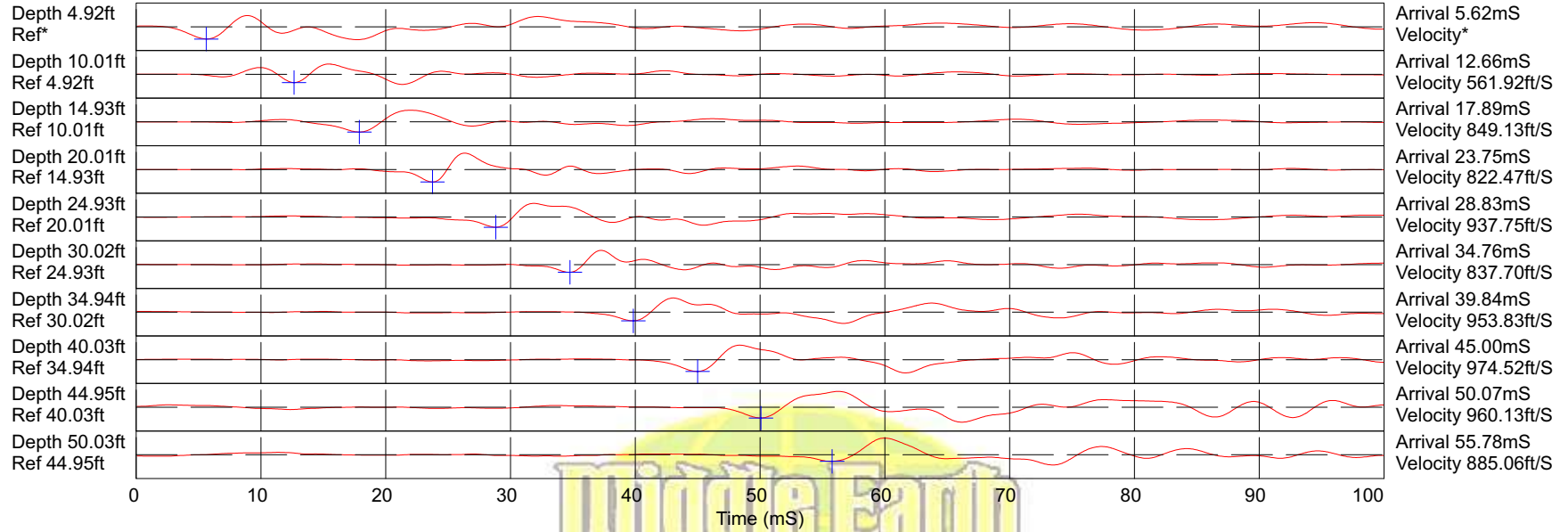
* Indicates the parameter was calculated using the normalized point stress.
 The parameters listed above were determined using empirical correlations.
 A Professional Engineer must determine their suitability for analysis and design.

Middle Earth Geo Testing

CPT-02

Mid Pacific Engineering

Humboldt County CCRC



Hammer to Rod String Distance (ft): 5.83

* = Not Determined

COMMENT:



Mid Pacific Engineering

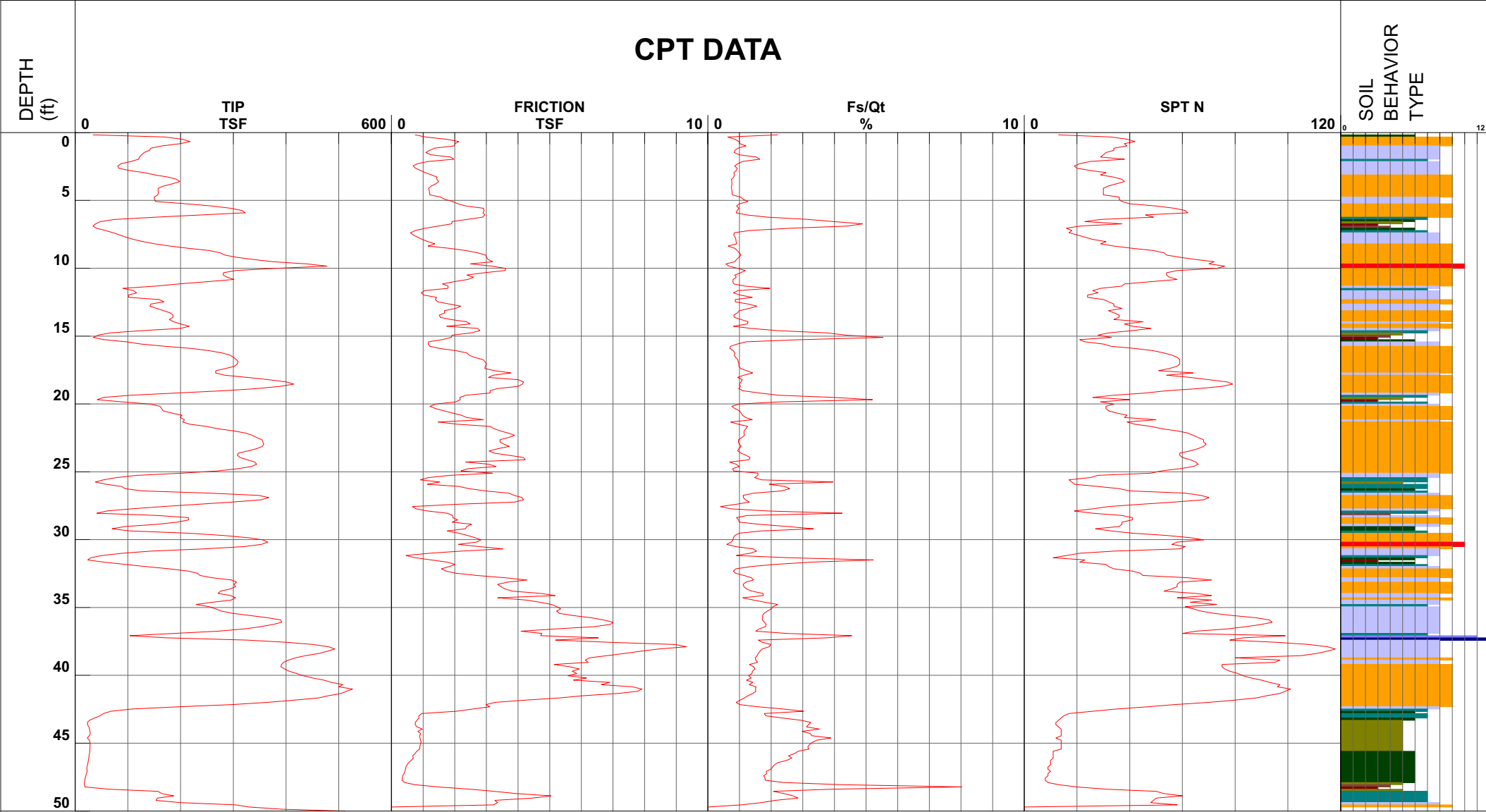
Project Humboldt County CCRC
 Job Number 04769-01
 Hole Number CPT-02
 EST GW Depth During Test

Operator BH
 Cone Number DDG1489
 Date and Time 10/3/2019 11:31:52 AM
 13.00 ft

Filename SDF(918).cpt
 GPS
 Maximum Depth 50.03 ft

Net Area Ratio .8

CPT DATA



Cone Size 10cm squared

S*Soil behavior type and SPT based on data from UBC-1983

Humboldt County CCRC

Project ID: Mid Pacific Engineering
Data File: SDF(919).cpt
CPT Date: 10/3/2019 12:32:37 PM
GW During Test: 13 ft

Page: 3
Sounding ID: CPT-03
Project No: 04769-01
Cone/Rig: DDG1489

Table with columns: Depth, qc, qcln, qncs, qt, Slv pore, Frct, Mat, Material Behavior, Unit Wght, Qc, SPT, SPT, SPT, Rel, Ftn, Und, OCR, Fin, D50, Ic, Nk. Rows contain detailed test data for various soil samples.

* Indicates the parameter was calculated using the normalized point stress. The parameters listed above were determined using empirical correlations. A Professional Engineer must determine their suitability for analysis and design.

Humboldt County CCRC

Project ID: Mid Pacific Engineering
 Data File: SDF(919).cpt
 CPT Date: 10/3/2019 12:32:37 PM
 GW During Test: 13 ft

Page: 4
 Sounding ID: CPT-03
 Project No: 04769-01
 Cone/Rig: DDG1489

Depth ft	qc PS	* qc1n PS	* q1ncs PS	* qt PS	* Slv Stss	* pore prss	* Frct Rato	* Mat Typ	* Material Behavior Description	* Unit Wght pcf	* Qc to N	* SPT R-N1 60%	* SPT R-N 60%	* SPT IcN1 60%	* Rel Den	* Ftn Ang deg	* Und Shr tsf	* OCR -	* Fin Ic %	* D50 mm	* Ic SBT	* Nk Indx
46.43	417.4	302.6	304.1	417.4	5.2	-1.2	1.3	6	clean SAND to silty SAND	125	5.0	61	83	52	95	45	-	-	5	0.350	1.65	16
46.59	434.8	314.7	314.7	434.8	4.2	-0.8	1.0	6	clean SAND to silty SAND	125	5.0	63	87	53	95	45	-	-	5	0.350	1.56	16
46.75	380.5	275.0	275.0	380.5	3.0	-0.5	0.8	6	clean SAND to silty SAND	125	5.0	55	76	46	95	44	-	-	5	0.350	1.53	16
46.92	357.5	258.0	258.0	357.5	3.5	-1.0	1.0	6	clean SAND to silty SAND	125	5.0	52	71	44	95	44	-	-	5	0.350	1.61	16
47.08	439.0	316.4	316.4	439.0	3.7	0.5	0.8	6	clean SAND to silty SAND	125	5.0	63	88	52	95	45	-	-	5	0.350	1.50	16
47.25	462.2	332.7	332.7	462.2	4.2	2.1	0.9	6	clean SAND to silty SAND	125	5.0	67	92	55	95	45	-	-	5	0.350	1.52	16
47.41	446.2	320.7	320.7	446.2	4.5	2.0	1.0	6	clean SAND to silty SAND	125	5.0	64	89	54	95	45	-	-	5	0.350	1.56	16
47.57	488.1	350.3	350.3	488.1	5.0	2.2	1.0	6	clean SAND to silty SAND	125	5.0	70	98	58	95	45	-	-	5	0.350	1.54	16
47.74	482.4	345.7	345.7	482.4	5.4	2.5	1.1	6	clean SAND to silty SAND	125	5.0	69	96	58	95	45	-	-	5	0.350	1.58	16
47.90	473.6	339.0	339.0	473.7	5.6	2.6	1.2	6	clean SAND to silty SAND	125	5.0	68	95	58	95	45	-	-	5	0.350	1.60	16
48.07	444.8	317.9	316.9	444.8	5.6	3.5	1.3	6	clean SAND to silty SAND	125	5.0	64	89	55	95	45	-	-	5	0.350	1.64	16
48.23	417.7	298.1	299.8	417.8	5.2	2.9	1.3	6	clean SAND to silty SAND	125	5.0	60	84	52	95	45	-	-	5	0.350	1.65	16
48.39	423.4	301.8	303.9	423.4	5.3	2.3	1.3	6	clean SAND to silty SAND	125	5.0	60	85	52	95	45	-	-	5	0.350	1.66	16
48.56	430.6	306.5	306.9	430.7	5.4	2.5	1.3	6	clean SAND to silty SAND	125	5.0	61	86	53	95	45	-	-	5	0.350	1.65	16
48.72	388.1	275.8	275.8	388.1	4.1	2.6	1.1	6	clean SAND to silty SAND	125	5.0	55	78	47	95	44	-	-	5	0.350	1.62	16
48.89	329.9	234.1	239.2	329.9	3.6	1.8	1.1	6	clean SAND to silty SAND	125	5.0	47	66	41	95	43	-	-	6	0.350	1.68	16
49.05	257.5	182.5	217.3	257.6	4.5	1.4	1.8	6	clean SAND to silty SAND	125	5.0	37	52	35	87	42	-	-	10	0.350	1.90	16
49.22	225.4	159.5	210.4	225.4	4.9	1.2	2.2	5	silty SAND to sandy SILT	120	4.0	40	56	31	82	41	-	-	13	0.200	2.01	16
49.38	158.0	111.7	194.1	158.0	4.8	1.1	3.1	5	silty SAND to sandy SILT	120	4.0	28	39	24	71	40	-	-	20	0.200	2.23	16
49.54	136.0	96.1	177.9	136.1	4.1	2.1	3.1	5	silty SAND to sandy SILT	120	4.0	24	34	21	66	39	-	-	21	0.200	2.27	16
49.71	193.4	136.4	155.5	193.4	2.1	3.1	1.1	6	clean SAND to silty SAND	125	5.0	27	39	25	77	41	-	-	9	0.350	1.84	16
49.87	211.4	148.9	166.3	211.5	2.3	1.7	1.1	6	clean SAND to silty SAND	125	5.0	30	42	27	80	41	-	-	8	0.350	1.81	16

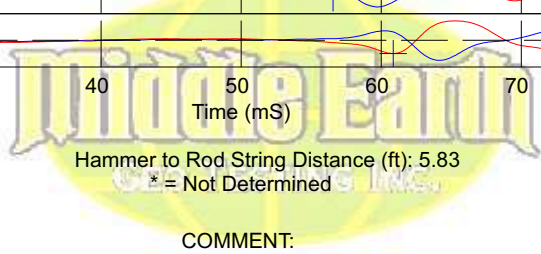
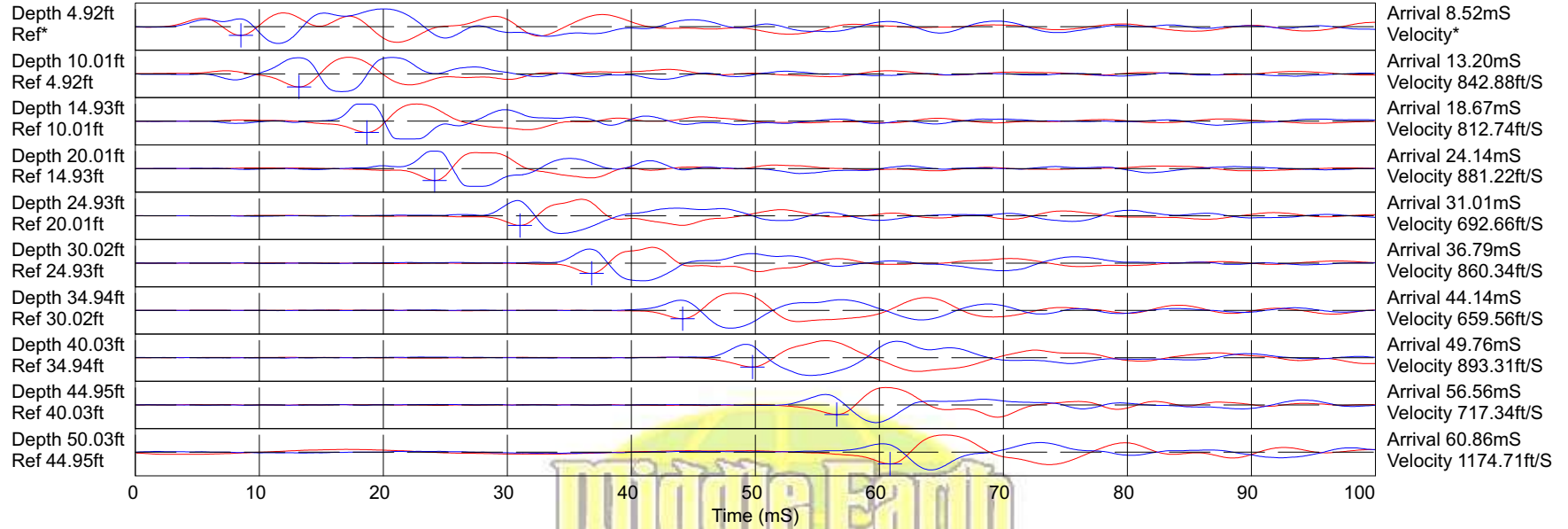
* Indicates the parameter was calculated using the normalized point stress.
 The parameters listed above were determined using empirical correlations.
 A Professional Engineer must determine their suitability for analysis and design.

Middle Earth Geo Testing

CPT-03

Mid Pacific Engineering

Humboldt County CCRC



Hammer to Rod String Distance (ft): 5.83

* = Not Determined

COMMENT:



Mid Pacific Engineering

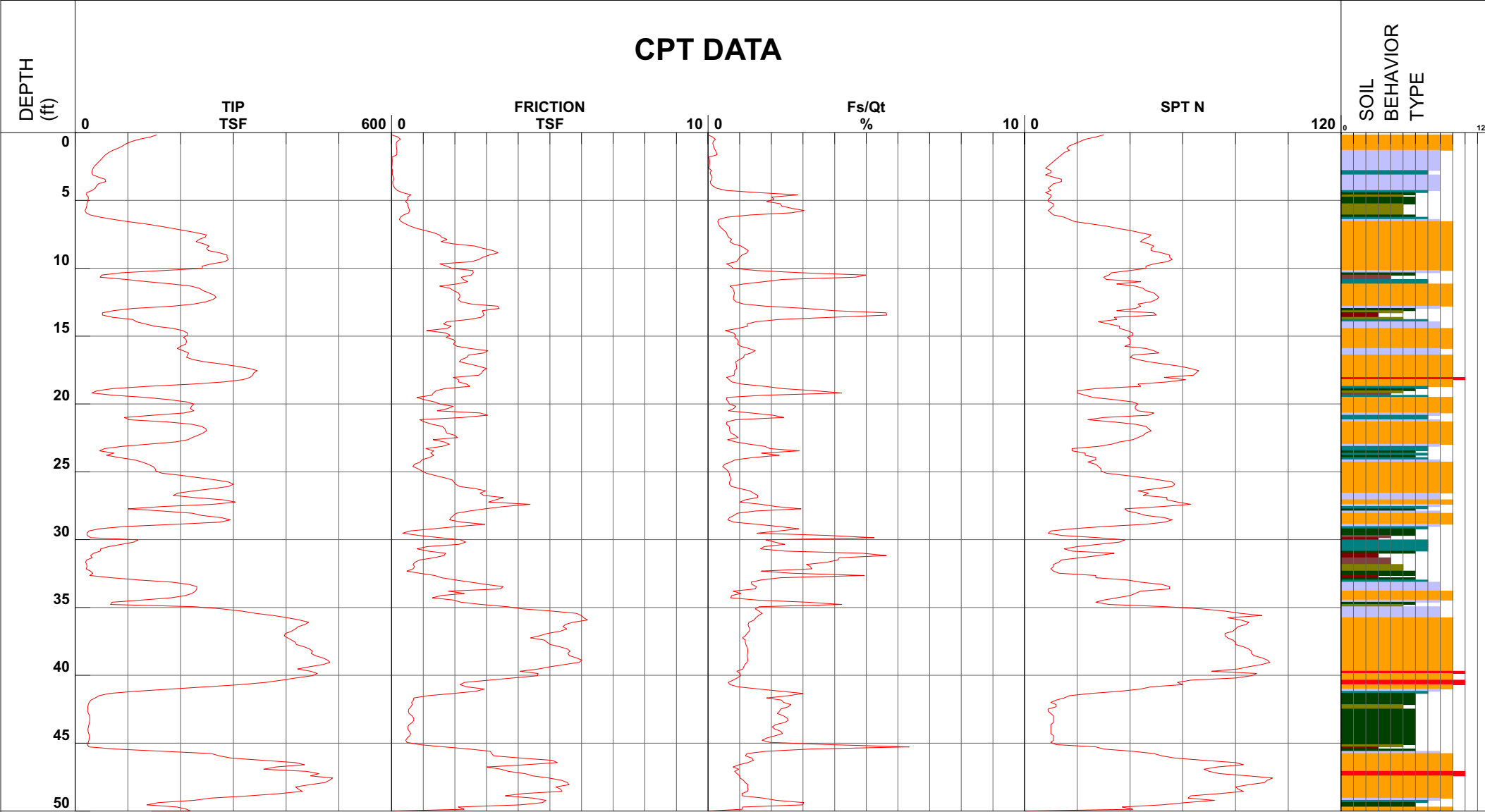
Project Humboldt County CCRC
 Job Number 04769-01
 Hole Number CPT-03
 EST GW Depth During Test

Operator BH
 Cone Number DDG1489
 Date and Time 10/3/2019 12:32:37 PM
 13.00 ft

Filename SDF(919).cpt
 GPS
 Maximum Depth 50.36 ft

Net Area Ratio .8

CPT DATA



SOIL
BEHAVIOR
TYPE

- 1 - sensitive fine grained
- 4 - silty clay to clay
- 7 - silty sand to sandy silt
- 10 - gravelly sand to sand
- 2 - organic material
- 5 - clayey silt to silty clay
- 8 - sand to silty sand
- 11 - very stiff fine grained (*)
- 3 - clay
- 6 - sandy silt to clayey silt
- 9 - sand
- 12 - sand to clayey sand (*)

Cone Size 10cm squared

S*Soil behavior type and SPT based on data from UBC-1983

APPENDIX D

TABLE OF CONTENTS

CPT-01 results	
Summary data report	1
Transition layer algorithm summary report	7
Transition layer algorithm data report	8
Input field data	9
Cyclic stress resistance results	16
Cyclic resistance ratio results	23
Liquefaction potential index data	30
Vertical settlements summary report	34
Vertical settlements data report	35
Strength loss data report	39
CPT-02 results	
Summary data report	46
Transition layer algorithm summary report	52
Transition layer algorithm data report	53
Input field data	54
Cyclic stress resistance results	61
Cyclic resistance ratio results	68
Liquefaction potential index data	75
Vertical settlements summary report	79
Vertical settlements data report	80
Strength loss data report	84
CPT-03 results	
Summary data report	91
Transition layer algorithm summary report	97
Transition layer algorithm data report	98
Input field data	99
Cyclic stress resistance results	106
Cyclic resistance ratio results	113
Liquefaction potential index data	120
Vertical settlements summary report	124
Vertical settlements data report	125
Strength loss data report	129

LIQUEFACTION ANALYSIS REPORT

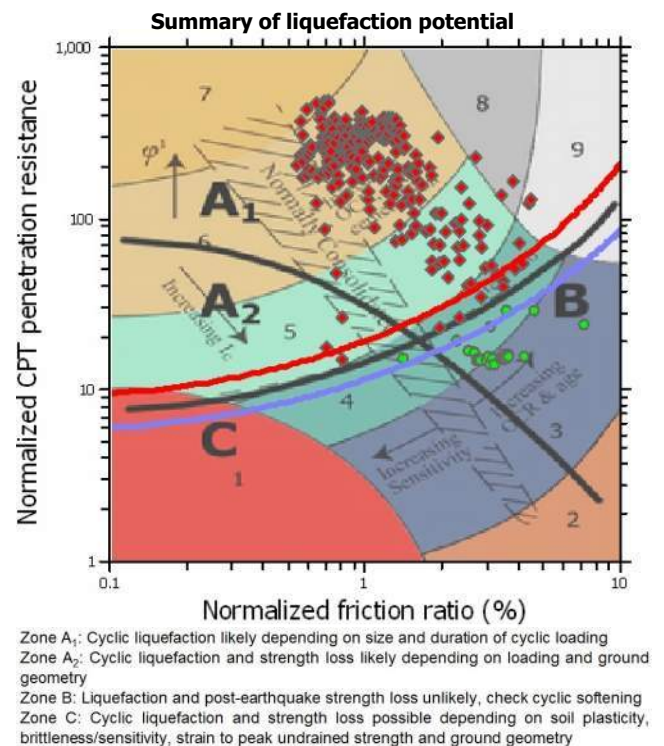
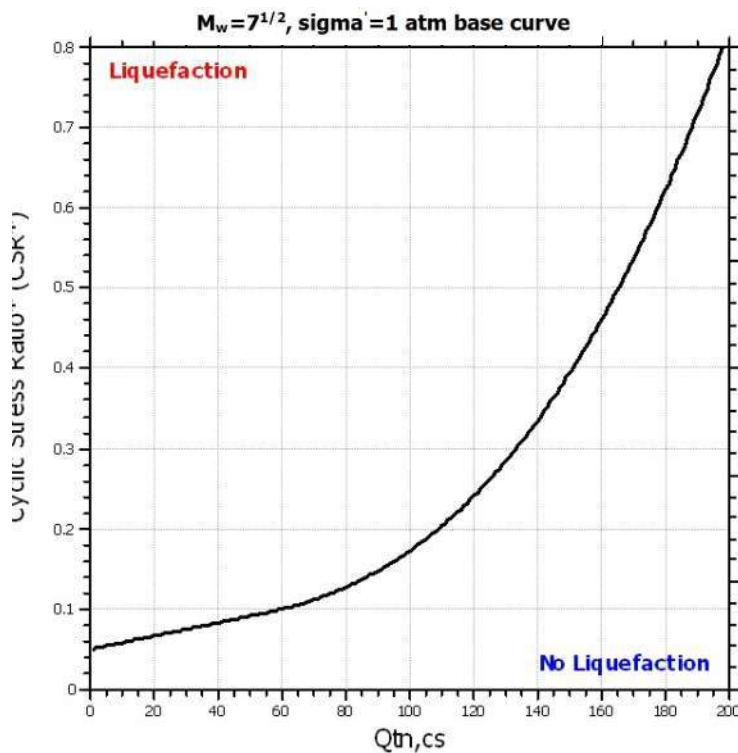
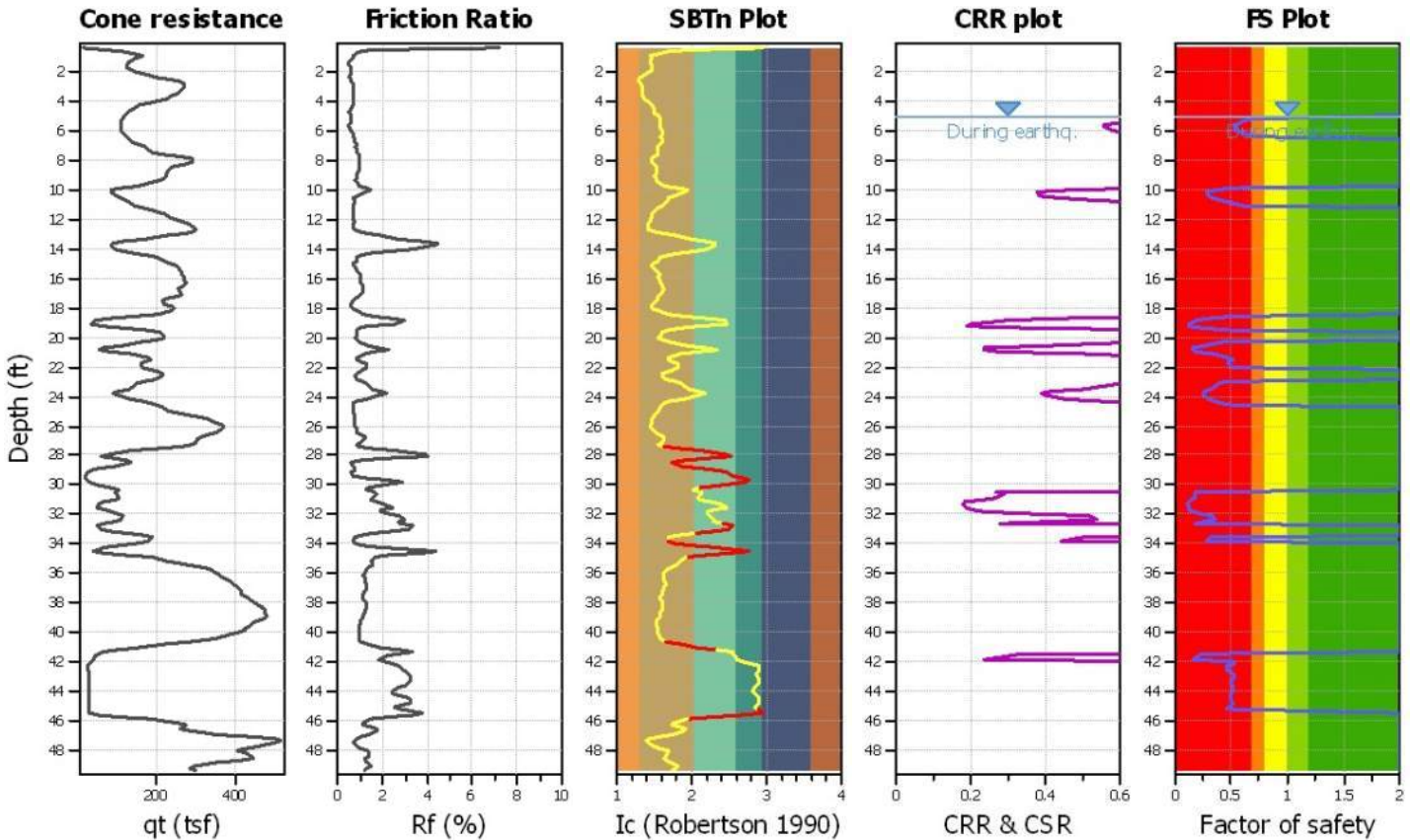
Project title :

Location :

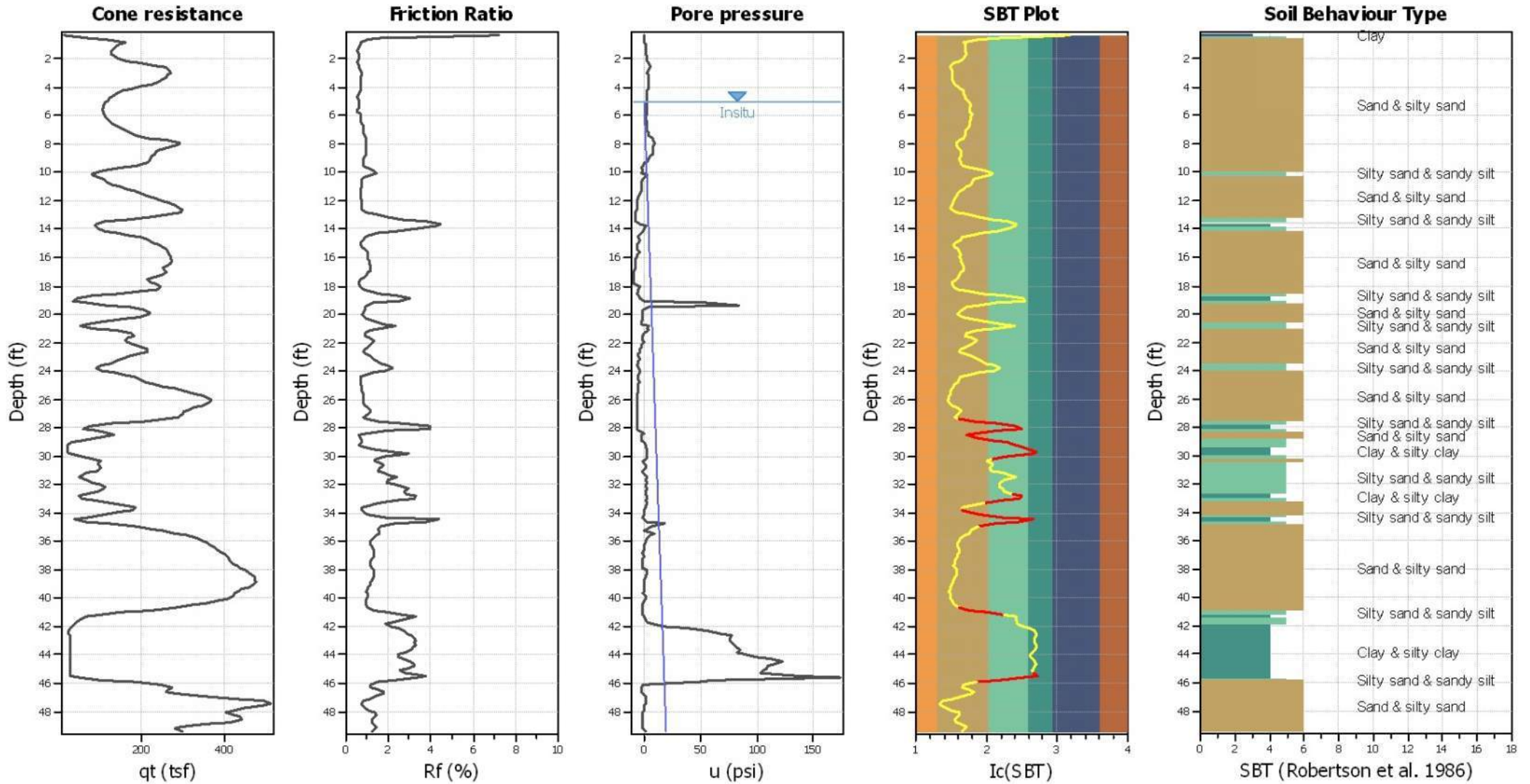
CPT file : CPT-01

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	5.00 ft	Use fill:	No	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	5.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w :	8.10	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	1.27	Unit weight calculation:	Based on SBT	K_0 applied:	No		



CPT basic interpretation plo



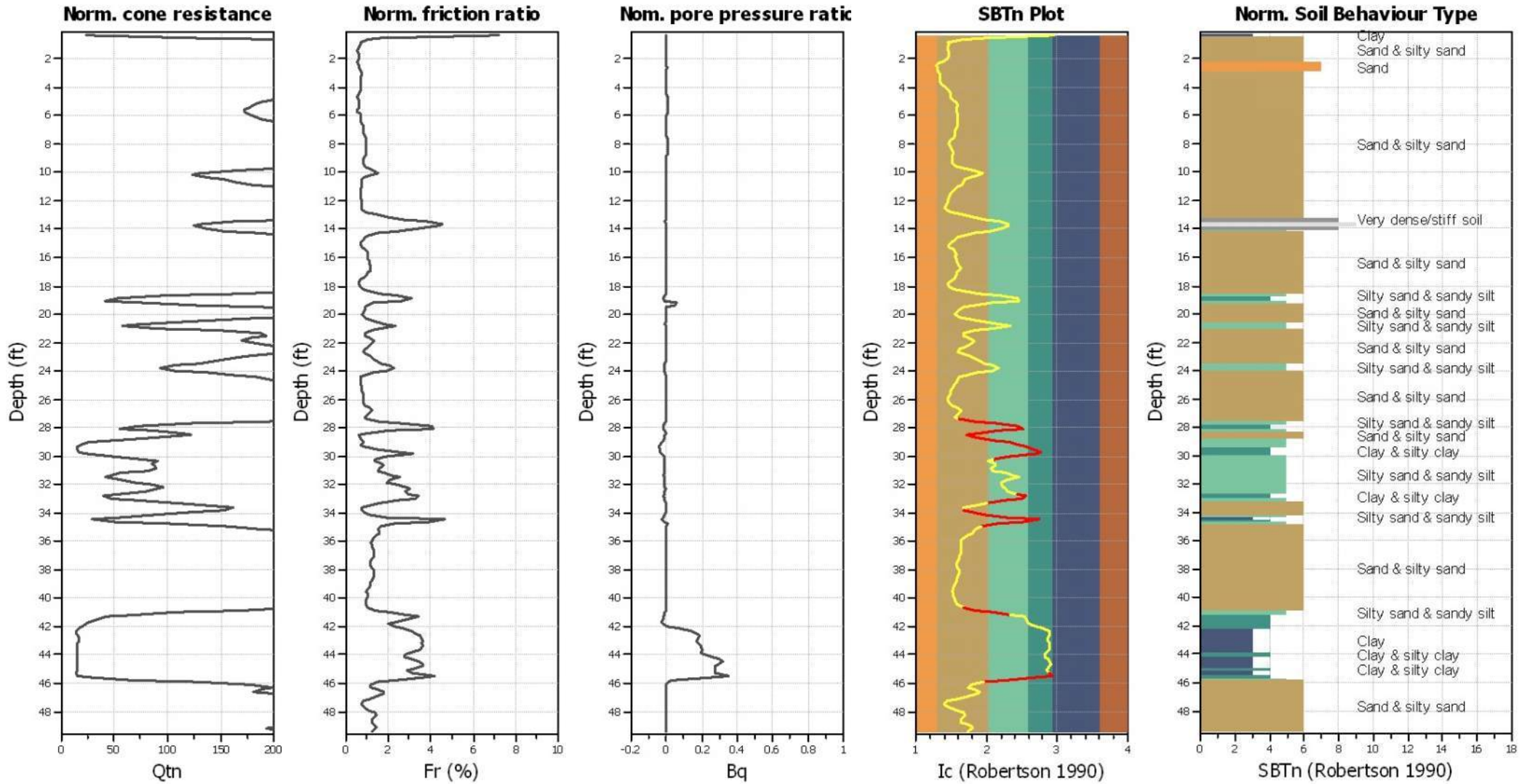
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	5.00 ft	Fill weight:	N/A
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _v applied:	No
Earthquake magnitude M _w :	8.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	1.27	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	5.00 ft	Fill height:	N/A	Limit depth:	N/A

SBT legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

CPT basic interpretation plots (normaliz



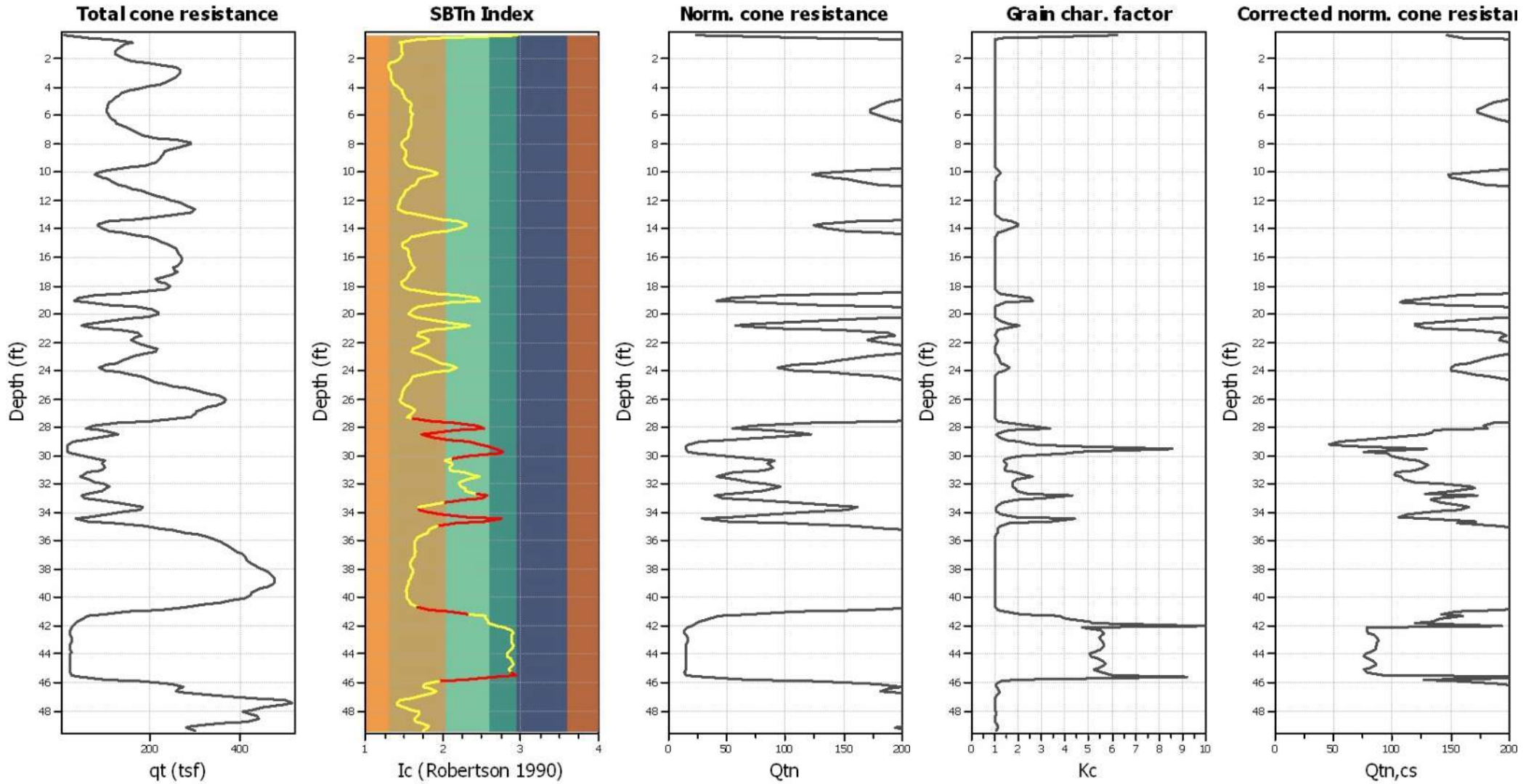
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	5.00 ft	Fill weight:	N/A
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _v applied:	No
Earthquake magnitude M _w :	8.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	1.27	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	5.00 ft	Fill height:	N/A	Limit depth:	N/A

SBTn legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

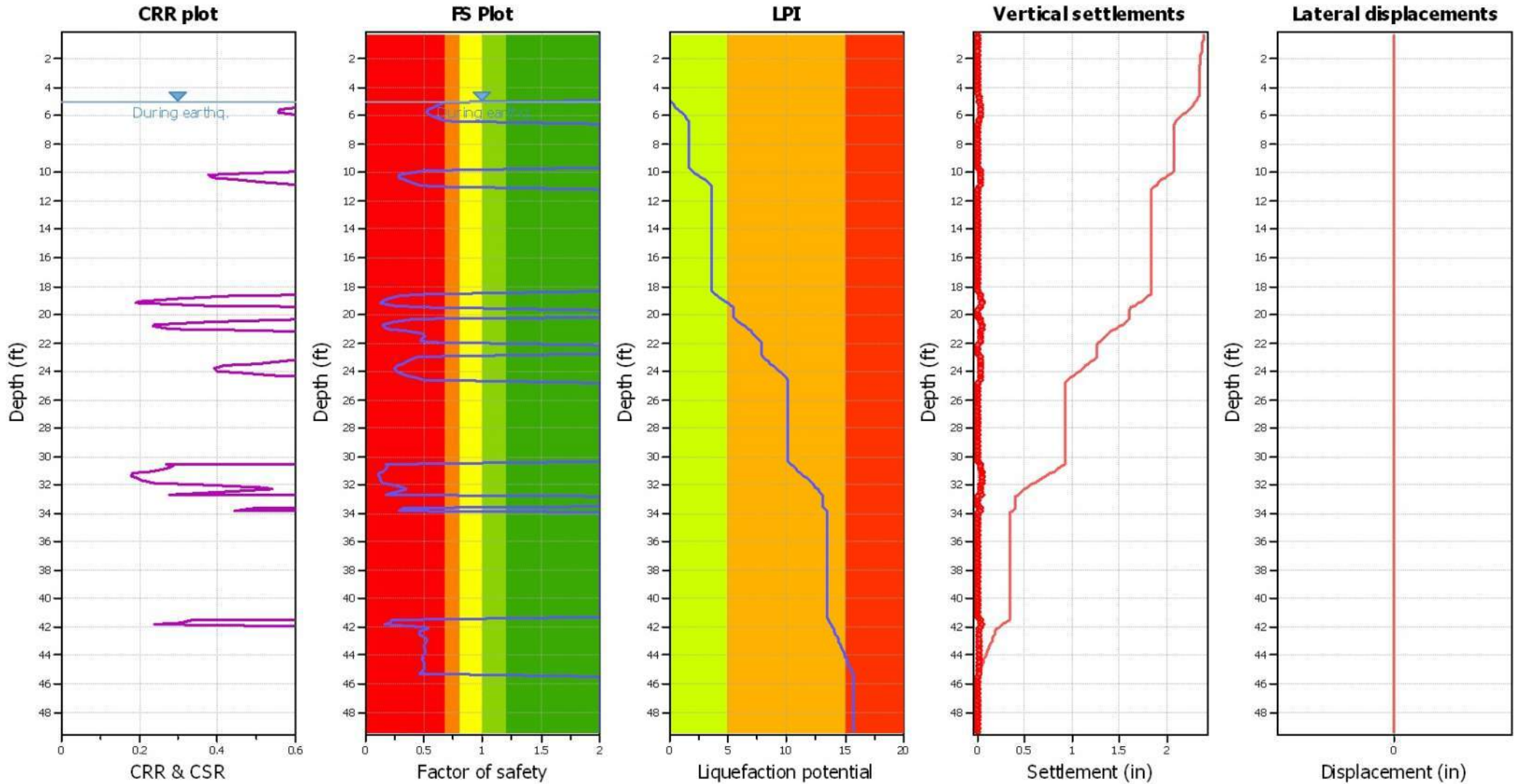
Liquefaction analysis overall plots (intermediate resu



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	5.00 ft	Fill weight:	N/A
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _v applied:	No
Earthquake magnitude M _w :	8.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	1.27	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	5.00 ft	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plot



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (earthq.):	5.00 ft	Fill weight:	N/A
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _v applied:	No
Earthquake magnitude M _w :	8.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	1.27	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	5.00 ft	Fill height:	N/A	Limit depth:	N/A

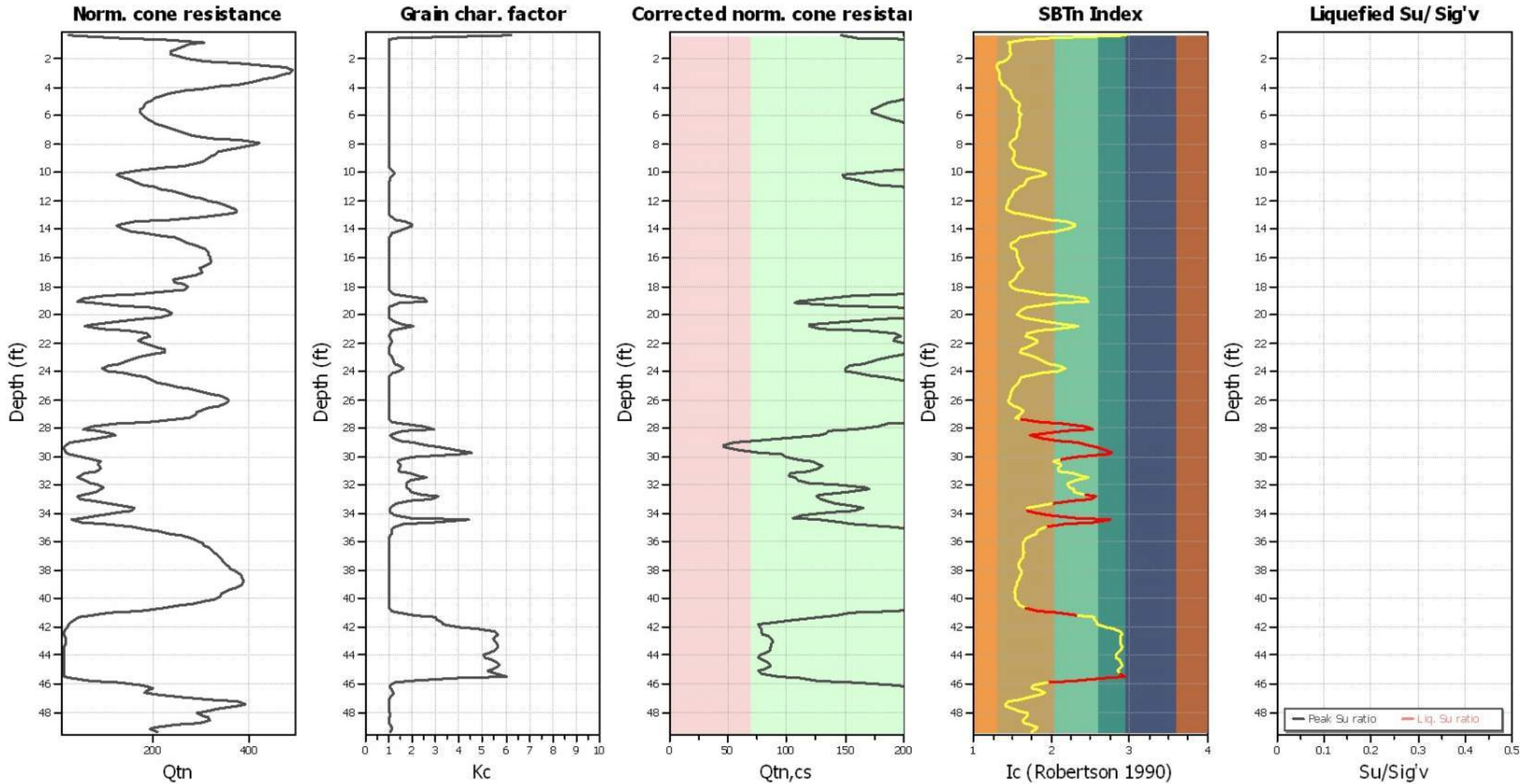
F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	5.00 ft	Fill weight:	N/A
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _c applied:	No
Earthquake magnitude M _w :	8.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	1.27	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	5.00 ft	Fill height:	N/A	Limit depth:	N/A

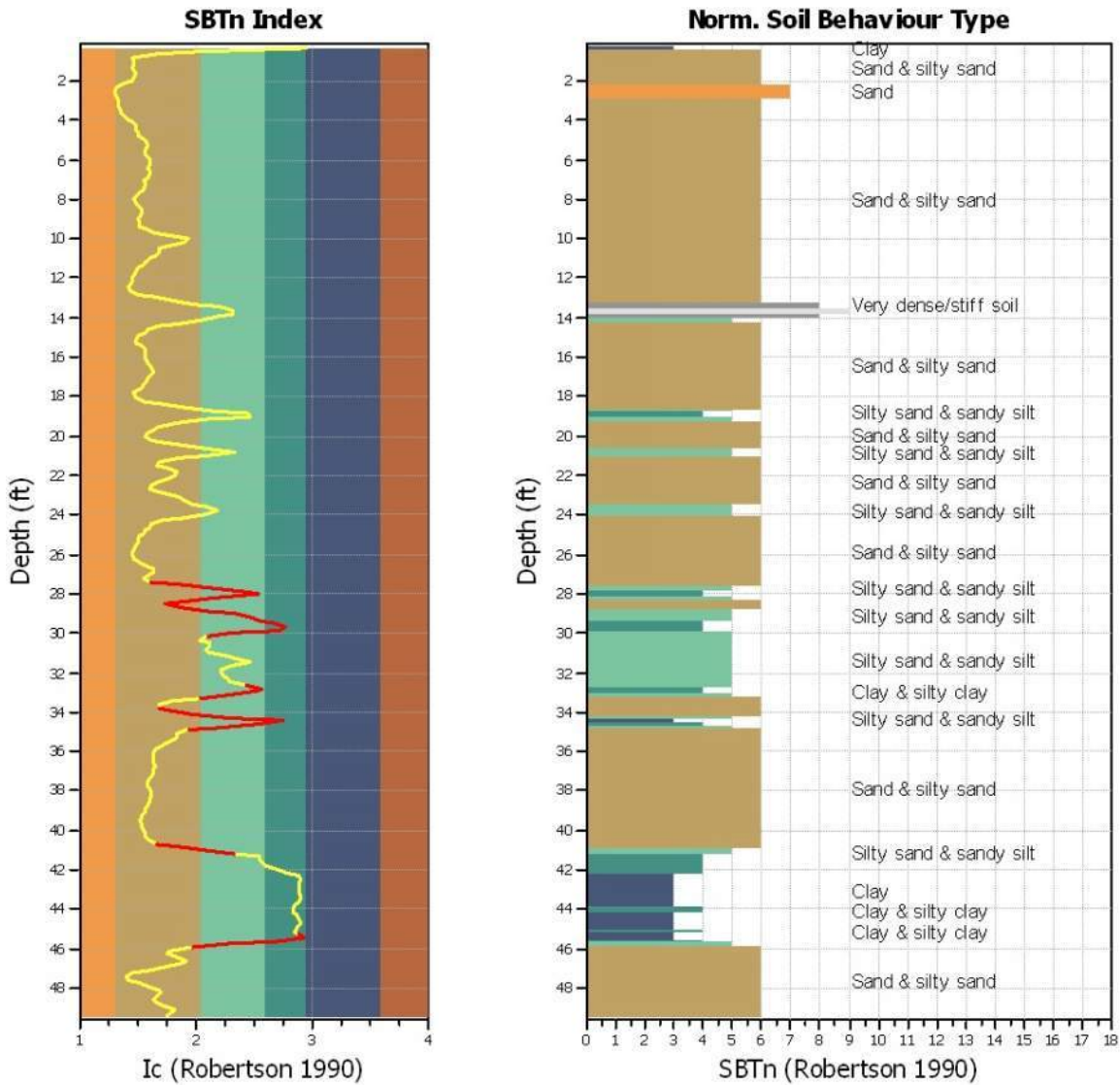
TRANSITION LAYER DETECTION ALGORITHM REPORT

Summary Details & Plots

Short description

The software will delete data when the cone is in transition from either clay to sand or vice-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between $1.80 < I_c < 3.0$) and a rate of change of I_c . Transitions typically occur when the rate of change of I_c is fast (i.e. ΔI_c is small).

The SBT_n plot below, displays in red the detected transition layers based on the parameters listed below the graphs.



Transition layer algorithm properties		General statistics	
I_c minimum check value:	1.70	Total points in CPT file:	300
I_c maximum check value:	3.00	Total points excluded:	44
I_c change ratio value:	0.0250	Exclusion percentage:	14.67%
Minimum number of points in layer:	4	Number of layers detected:	9

Transition layer No	Number of points	Depth	SBT _n number	SBT _n description
Transition layer 1	4	Start depth: 27.56 (ft)	6	Sand & silty sand
		End depth: 28.05 (ft)	4	Clay & silty clay
Transition layer 2	4	Start depth: 28.05 (ft)	4	Clay & silty clay
		End depth: 28.54 (ft)	6	Sand & silty sand
Transition layer 3	8	Start depth: 28.54 (ft)	6	Sand & silty sand
		End depth: 29.69 (ft)	4	Clay & silty clay
Transition layer 4	5	Start depth: 29.69 (ft)	4	Clay & silty clay
		End depth: 30.35 (ft)	5	Silty sand & sandy silt
Transition layer 5	5	Start depth: 32.81 (ft)	4	Clay & silty clay
		End depth: 33.47 (ft)	6	Sand & silty sand
Transition layer 6	4	Start depth: 33.96 (ft)	6	Sand & silty sand
		End depth: 34.45 (ft)	3	Clay
Transition layer 7	5	Start depth: 34.45 (ft)	3	Clay
		End depth: 35.11 (ft)	6	Sand & silty sand
Transition layer 8	4	Start depth: 40.85 (ft)	6	Sand & silty sand
		End depth: 41.34 (ft)	4	Clay & silty clay
Transition layer 9	5	Start depth: 45.44 (ft)	3	Clay
		End depth: 46.10 (ft)	6	Sand & silty sand

Start depth: Depth where the transition layer begins

End depth: Depth where the transition layer ends

:: Field input data ::						
Point ID	Depth (ft)	q _c (tsf)	f _s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
1	0.33	13.30	0.80	0.00	55.33	115.66
2	0.49	10.90	1.10	0.00	11.65	120.82
3	0.66	180.90	1.20	0.00	5.46	122.99
4	0.82	156.40	1.20	0.30	2.19	123.58
5	0.98	146.40	1.00	1.40	2.49	122.43
6	1.15	135.00	0.80	1.00	2.27	120.94
7	1.31	129.20	0.70	1.20	2.25	119.85
8	1.48	122.70	0.70	1.40	2.33	119.44
9	1.64	123.20	0.70	1.60	2.50	119.78
10	1.80	129.50	0.80	1.80	2.48	120.53
11	1.97	139.60	0.90	2.20	2.11	121.32
12	2.13	157.60	0.90	2.70	1.33	122.20
13	2.30	193.30	1.00	3.40	0.66	123.84
14	2.46	236.80	1.40	4.30	0.33	125.84
15	2.62	266.40	1.70	5.00	0.41	127.55
16	2.79	270.50	1.90	3.10	0.59	128.48
17	2.95	268.10	2.00	2.90	0.75	128.74
18	3.12	267.00	1.90	3.30	0.84	128.57
19	3.28	256.10	1.80	3.40	0.84	128.12
20	3.45	250.70	1.70	3.10	0.86	127.63
21	3.61	246.00	1.60	3.30	0.97	127.08
22	3.77	223.90	1.50	3.40	1.24	126.43
23	3.94	200.20	1.40	3.10	1.67	125.48
24	4.10	176.50	1.20	3.10	2.11	124.22
25	4.27	152.40	1.00	2.80	2.54	122.82
26	4.43	136.90	0.90	2.60	2.66	120.96
27	4.59	126.20	0.60	2.60	2.80	119.86
28	4.76	124.10	0.70	2.70	2.88	119.05
29	4.92	119.60	0.70	2.80	3.47	119.29
30	5.09	109.30	0.70	2.60	3.86	119.19
31	5.25	109.30	0.70	2.80	4.20	119.10
32	5.41	107.60	0.70	2.80	3.94	118.34
33	5.58	105.60	0.50	2.80	3.90	117.91
34	5.74	104.40	0.60	2.70	3.90	117.92
35	5.91	108.90	0.70	2.80	4.46	119.06
36	6.07	107.80	0.80	1.60	4.45	119.84
37	6.23	119.70	0.80	1.50	4.42	120.56
38	6.40	124.70	0.90	1.70	4.18	120.97
39	6.56	125.70	0.90	1.80	4.30	121.87
40	6.73	135.50	1.10	2.00	4.29	122.98
41	6.89	152.10	1.30	2.30	4.09	124.25
42	7.05	167.60	1.40	2.60	3.69	125.02
43	7.22	177.50	1.40	3.00	3.72	125.63
44	7.38	170.20	1.60	3.70	3.63	126.76
45	7.55	211.10	2.00	7.20	3.46	128.67
46	7.71	261.30	2.60	7.00	2.79	130.54
47	7.87	307.10	2.90	8.60	2.46	131.64
48	8.04	303.20	2.90	8.80	2.45	131.55

:: Field input data :: (continued)

Point ID	Depth (ft)	q _c (tsf)	f _s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
49	8.20	259.10	2.50	7.90	2.71	130.70
50	8.37	237.80	2.20	7.40	3.03	129.76
51	8.53	232.20	2.20	7.50	3.24	129.45
52	8.69	230.80	2.30	7.00	3.26	129.19
53	8.86	226.30	2.00	4.50	3.15	128.68
54	9.02	218.90	1.80	3.40	2.91	128.02
55	9.19	221.00	1.80	2.40	3.05	127.83
56	9.35	210.30	1.90	-0.30	3.12	127.33
57	9.51	196.20	1.50	-1.80	3.73	126.47
58	9.68	154.70	1.40	-2.60	5.04	125.18
59	9.84	110.10	1.40	-2.10	8.68	124.19
60	10.01	63.80	1.40	-2.30	11.39	122.61
61	10.17	78.30	0.90	2.20	10.53	120.99
62	10.34	100.50	0.70	-0.20	7.17	119.76
63	10.50	107.90	0.80	-2.10	5.94	120.04
64	10.66	113.80	0.90	-2.30	5.68	121.11
65	10.83	128.30	1.00	-2.50	5.18	122.13
66	10.99	145.50	1.10	-2.60	4.37	122.89
67	11.16	162.40	1.10	-2.80	3.75	123.82
68	11.32	181.10	1.30	-3.10	3.23	124.68
69	11.48	198.50	1.40	-3.90	2.86	125.65
70	11.65	218.00	1.50	-4.90	2.49	126.35
71	11.81	232.90	1.60	-5.80	2.36	127.30
72	11.98	247.80	1.90	-6.40	2.21	128.02
73	12.14	263.10	1.90	-6.90	2.12	128.81
74	12.30	279.00	2.10	-7.30	1.84	129.20
75	12.47	295.60	2.10	-6.40	1.76	129.78
76	12.63	303.30	2.30	-7.00	1.86	130.27
77	12.80	297.20	2.50	-7.40	2.89	131.76
78	12.96	282.50	3.70	-7.70	5.00	133.44
79	13.12	233.60	4.80	-8.00	8.14	134.15
80	13.29	158.00	4.40	-8.30	12.65	133.69
81	13.45	106.10	4.20	-7.80	18.73	132.36
82	13.62	75.30	4.10	-3.80	22.91	131.30
83	13.78	85.60	3.60	0.50	22.97	130.62
84	13.94	94.30	3.30	-0.40	19.12	129.89
85	14.11	105.70	2.70	-1.20	14.25	128.87
86	14.27	136.90	1.90	-3.10	9.21	127.75
87	14.44	176.90	1.70	-4.80	5.79	127.13
88	14.60	203.20	1.80	-5.70	4.20	127.20
89	14.76	215.30	1.70	-3.80	3.64	127.68
90	14.93	228.40	1.90	-5.50	2.74	127.11
91	15.09	241.60	1.30	-6.10	2.49	127.53
92	15.26	252.60	1.90	-6.50	2.57	128.46
93	15.42	265.30	2.50	-6.90	3.36	130.13
94	15.58	260.30	2.70	-4.70	3.76	130.95
95	15.75	264.10	2.70	-6.50	3.83	131.15
96	15.91	272.20	2.70	-7.10	3.79	131.27

:: Field input data :: (continued)

Point ID	Depth (ft)	q _c (tsf)	f _s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
97	16.08	270.30	2.80	-7.50	3.87	131.46
98	16.24	269.60	2.90	-7.80	4.08	131.82
99	16.40	276.90	3.10	-8.00	4.31	131.96
100	16.57	261.90	3.00	-8.30	4.57	131.80
101	16.73	244.50	2.80	-8.50	4.88	131.73
102	16.90	254.20	3.10	-8.80	4.65	131.59
103	17.06	271.20	2.80	-8.90	4.11	131.11
104	17.23	258.30	2.20	-8.90	3.81	129.93
105	17.39	219.50	2.00	-9.10	3.51	127.79
106	17.55	198.70	1.20	-9.30	3.23	126.31
107	17.72	220.30	1.30	-9.30	2.39	125.35
108	17.88	241.40	1.40	-9.30	2.30	126.40
109	18.05	246.70	1.70	-4.00	2.59	127.58
110	18.21	248.70	2.00	-5.10	3.61	128.68
111	18.37	217.20	2.30	-6.00	5.86	129.21
112	18.54	142.50	2.50	-6.20	10.35	128.48
113	18.70	70.50	2.10	-5.90	18.10	125.87
114	18.87	35.60	1.20	-3.70	28.19	121.61
115	19.03	26.40	0.70	-0.90	29.32	117.87
116	19.19	41.20	0.70	54.60	15.54	119.07
117	19.36	121.80	1.10	83.70	8.75	122.99
118	19.52	182.00	1.70	3.30	5.76	126.10
119	19.69	208.90	1.90	-1.30	4.60	127.72
120	19.85	231.50	1.90	-1.70	4.11	128.00
121	20.01	221.20	1.80	-1.90	3.74	127.30
122	20.18	204.50	1.40	-1.80	4.77	127.04
123	20.34	166.40	1.90	-1.90	6.55	125.77
124	20.51	107.60	1.30	-2.60	11.55	124.68
125	20.67	52.70	1.30	-2.20	18.70	121.56
126	20.83	33.30	0.90	3.90	23.97	120.98
127	21.00	66.30	1.30	2.10	14.86	122.99
128	21.16	151.10	1.70	3.10	9.07	125.66
129	21.33	185.80	1.80	-0.80	5.80	126.32
130	21.49	190.20	1.30	-1.60	5.65	126.70
131	21.65	170.20	1.90	-1.80	7.07	127.22
132	21.82	147.10	2.30	-2.00	8.74	128.07
133	21.98	160.30	2.10	0.00	8.47	128.39
134	22.15	188.90	2.10	-2.40	7.16	128.51
135	22.31	197.90	2.20	-3.00	5.75	128.54
136	22.47	222.10	1.90	-3.50	4.58	127.94
137	22.64	226.50	1.50	-4.30	4.25	127.40
138	22.80	196.60	1.80	-4.90	5.26	127.16
139	22.97	162.20	1.90	-5.00	7.67	127.44
140	23.13	140.20	2.00	-4.70	9.36	127.43
141	23.30	145.40	2.00	-4.90	10.47	127.53
142	23.46	136.90	2.10	-5.70	12.17	127.26
143	23.62	96.50	2.00	-6.40	15.44	126.66
144	23.79	77.50	1.90	-5.60	18.19	126.32

:: Field input data :: (continued)

Point ID	Depth (ft)	q _c (tsf)	f _s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
145	23.95	95.90	2.10	-4.70	15.23	126.41
146	24.12	136.90	1.80	-4.70	10.13	126.08
147	24.28	166.00	1.20	-5.00	6.43	125.32
148	24.44	184.70	1.30	-5.30	4.67	124.89
149	24.61	196.90	1.40	-5.50	4.26	125.62
150	24.77	209.90	1.50	-3.70	3.94	126.29
151	24.94	225.70	1.60	-4.80	3.57	127.11
152	25.10	251.20	1.80	-5.30	3.19	128.20
153	25.26	281.90	2.10	-5.80	2.91	129.44
154	25.43	307.20	2.40	-6.00	2.74	130.64
155	25.59	330.40	2.70	-6.20	2.61	131.59
156	25.76	351.10	2.90	-6.30	2.40	132.18
157	25.92	367.70	2.90	-6.50	2.25	132.52
158	26.08	371.10	3.00	-6.40	2.20	132.64
159	26.25	367.10	3.00	-6.40	2.41	132.77
160	26.41	353.20	3.10	-6.50	3.05	133.06
161	26.58	324.10	3.50	-6.60	4.02	133.50
162	26.74	307.10	3.80	-6.70	4.96	133.92
163	26.90	305.30	3.90	-6.80	5.05	133.58
164	27.07	298.20	3.10	-6.90	4.24	132.30
165	27.23	294.50	2.10	-7.00	3.51	130.70
166	27.40	276.10	2.20	-7.10	4.68	130.64
167	27.56	212.40	3.30	-7.30	9.26	131.65
168	27.72	117.10	4.00	-7.30	16.90	130.89
169	27.89	62.20	2.60	-6.80	27.93	129.08
170	28.05	53.70	2.60	-6.10	31.86	126.52
171	28.22	61.70	1.90	-4.90	18.15	125.71
172	28.38	158.50	1.00	-0.60	9.96	123.73
173	28.54	147.30	0.90	-3.20	6.60	120.83
174	28.71	88.10	0.60	-3.40	9.55	118.00
175	28.87	46.10	0.40	-2.80	15.95	113.27
176	29.04	26.00	0.20	-0.60	23.92	107.96
177	29.20	19.40	0.10	0.50	29.26	102.94
178	29.36	17.10	0.10	1.20	33.34	102.60
179	29.53	17.90	0.20	1.70	39.01	106.71
180	29.69	19.70	0.40	2.00	44.46	112.03
181	29.86	22.90	0.80	2.40	41.18	116.72
182	30.02	39.70	1.20	2.30	22.87	120.12
183	30.19	107.20	1.00	1.40	15.52	122.26
184	30.35	110.80	1.30	-1.20	13.87	123.82
185	30.51	85.90	1.80	-0.90	16.47	124.82
186	30.68	88.20	1.70	1.10	16.52	125.49
187	30.84	121.70	1.70	1.10	15.14	124.82
188	31.01	93.60	1.30	-1.50	15.73	123.59
189	31.17	61.20	1.10	-1.20	21.47	121.35
190	31.33	38.60	1.00	0.40	25.55	120.69
191	31.50	61.80	1.20	1.90	29.26	120.85
192	31.66	44.30	1.30	1.30	22.42	122.42

:: Field input data :: (continued)

Point ID	Depth (ft)	q _c (tsf)	f _s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
193	31.83	92.40	1.40	1.80	19.64	124.11
194	31.99	106.00	1.90	0.50	19.59	127.32
195	32.15	93.90	3.40	1.00	20.18	129.88
196	32.32	133.00	3.80	2.00	21.68	130.09
197	32.48	92.00	2.30	0.40	22.16	128.35
198	32.65	57.90	1.70	1.10	27.71	124.69
199	32.81	39.90	1.40	1.70	33.63	123.37
200	32.97	50.10	1.80	1.90	31.07	124.41
201	33.14	79.00	2.20	1.50	21.91	126.16
202	33.30	123.70	2.00	1.70	13.32	126.91
203	33.47	177.90	1.60	1.50	8.18	126.63
204	33.63	198.00	1.50	0.80	5.79	125.65
205	33.79	182.70	1.20	0.20	5.83	124.82
206	33.96	152.30	1.20	-0.40	7.52	123.58
207	34.12	108.40	1.10	-0.90	12.12	122.58
208	34.29	60.40	1.10	-1.00	22.46	122.27
209	34.45	33.30	1.60	0.30	43.28	122.89
210	34.61	20.90	2.30	2.00	32.00	126.82
211	34.78	137.30	3.30	17.70	18.21	129.27
212	34.94	196.50	2.60	5.90	10.97	131.23
213	35.11	227.60	3.30	2.30	8.95	132.28
214	35.27	249.00	4.10	-0.10	8.68	133.91
215	35.43	281.70	4.60	9.00	8.01	134.86
216	35.60	310.80	4.50	5.10	6.83	135.15
217	35.76	335.40	4.20	2.40	5.72	135.05
218	35.93	351.80	4.10	1.10	5.09	134.99
219	36.09	356.30	4.20	0.60	4.88	135.18
220	36.26	367.10	4.40	0.30	4.86	135.45
221	36.42	373.60	4.50	0.00	4.93	135.89
222	36.58	383.10	4.90	-0.70	5.05	136.36
223	36.75	392.20	5.20	-1.00	5.14	136.80
224	36.91	401.10	5.30	-1.00	5.00	137.01
225	37.08	413.50	5.20	-0.90	4.80	137.00
226	37.24	411.20	5.10	-1.20	4.63	136.93
227	37.40	413.80	5.10	-1.20	4.28	136.61
228	37.57	422.80	4.50	-1.20	4.09	136.60
229	37.73	432.10	5.00	-1.30	4.04	136.85
230	37.90	441.70	5.50	-1.00	4.39	137.28
231	38.06	446.40	5.90	2.00	4.53	137.28
232	38.22	465.90	6.10	2.00	4.55	137.28
233	38.39	473.00	6.20	1.10	4.41	137.28
234	38.55	471.30	6.00	0.80	4.25	137.28
235	38.72	475.50	5.80	0.30	4.06	137.28
236	38.88	477.10	5.70	0.10	3.82	137.28
237	39.04	478.30	5.40	-0.10	3.74	137.28
238	39.21	463.10	5.30	-0.40	3.37	136.80
239	39.37	437.90	3.90	-0.50	3.31	136.14
240	39.54	427.70	4.30	-0.90	3.16	135.51

:: Field input data :: (continued)

Point ID	Depth (ft)	q _c (tsf)	f _s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
241	39.70	428.60	4.30	-1.00	3.44	135.65
242	39.86	417.60	4.20	1.20	3.44	135.51
243	40.03	417.80	4.10	0.40	3.52	135.14
244	40.19	391.60	3.80	-0.40	3.74	134.57
245	40.36	351.90	3.50	-1.00	3.96	133.48
246	40.52	321.80	2.80	-1.80	4.45	132.56
247	40.68	293.80	2.90	-1.70	5.56	131.64
248	40.85	225.10	2.80	-1.70	8.83	131.32
249	41.01	146.60	3.10	-1.70	15.43	130.27
250	41.18	75.40	2.80	-1.50	24.14	128.71
251	41.34	70.20	2.20	-0.90	32.65	125.97
252	41.50	47.50	1.40	0.70	33.20	122.58
253	41.67	40.80	0.70	1.80	34.85	118.57
254	41.83	35.40	0.60	6.40	34.99	116.08
255	42.00	33.00	0.70	17.30	40.29	115.72
256	42.16	25.10	0.70	36.60	45.71	115.38
257	42.32	22.50	0.60	56.40	50.99	115.07
258	42.49	22.50	0.70	67.90	51.75	115.43
259	42.65	24.70	0.80	77.20	51.35	116.56
260	42.82	26.90	0.90	76.50	50.67	117.27
261	42.98	26.30	0.90	76.00	50.76	117.58
262	43.15	25.90	0.90	76.80	51.11	117.25
263	43.31	25.10	0.80	80.30	51.89	117.21
264	43.47	24.90	0.90	80.60	51.63	116.91
265	43.64	25.20	0.80	84.40	50.85	116.96
266	43.80	26.70	0.80	82.10	48.72	116.03
267	43.97	25.10	0.60	88.30	47.63	115.32
268	44.13	24.40	0.60	99.50	48.04	114.87
269	44.29	24.10	0.70	110.40	49.55	115.61
270	44.46	24.80	0.80	121.90	51.22	116.62
271	44.62	25.20	0.90	114.90	52.08	117.24
272	44.79	25.10	0.90	110.00	51.89	117.25
273	44.95	25.50	0.80	108.80	50.09	116.35
274	45.11	25.10	0.60	106.00	48.85	115.27
275	45.28	23.50	0.60	103.00	51.36	115.53
276	45.44	22.00	0.90	137.20	54.20	118.59
277	45.61	31.00	1.60	174.20	39.57	123.31
278	45.77	86.30	2.40	58.80	21.85	127.66
279	45.93	186.00	2.90	49.00	11.78	130.12
280	46.10	267.70	2.70	-2.10	7.50	131.33
281	46.26	287.40	2.90	-2.20	6.95	132.48
282	46.43	269.30	4.00	-2.30	8.76	133.79
283	46.59	241.90	4.70	-2.30	10.67	135.04
284	46.75	265.10	5.20	-1.80	10.00	135.81
285	46.92	339.00	5.10	0.90	6.79	136.25
286	47.08	453.60	4.50	0.60	4.02	136.37
287	47.25	516.10	4.40	0.60	2.21	135.86
288	47.41	522.00	3.60	0.50	1.61	135.39

:: Field input data :: (continued)

Point ID	Depth (ft)	q _c (tsf)	f _s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
289	47.57	503.50	3.60	0.30	1.63	134.93
290	47.74	469.10	3.80	-0.60	2.76	135.14
291	47.90	382.00	4.30	-0.30	4.21	136.08
292	48.07	419.30	5.50	-1.00	5.84	137.25
293	48.23	410.50	6.40	-1.80	5.99	137.28
294	48.39	446.10	6.20	-2.10	5.56	137.28
295	48.56	459.30	5.30	-1.20	4.89	137.28
296	48.72	419.80	4.80	-2.10	5.16	136.85
297	48.89	365.30	5.10	-2.00	6.48	135.80
298	49.05	275.30	4.00	-1.90	8.37	134.75
299	49.22	240.00	3.70	-2.00	8.03	133.73
300	49.38	329.50	3.60	0.90	6.95	133.62

Abbreviations

Depth:	Depth from free surface, at which CPT was performed (ft)
q _c :	Measured cone resistance (tsf)
f _s :	Sleeve friction resistance (tsf)
u:	Pore pressure (tsf)
Fines content:	Percentage of fines in soil (%)
Unit weight:	Bulk soil unit weight (pcf)

:: Cyclic Stress Ratio fully adjusted (CSR*) calculation data ::												
Point ID	Depth (ft)	σ_v (tsf)	u_0 (tsf)	σ'_v (tsf)	r_d	CSR	MSF	CSR_{eq}	K_G	User FS	CSR*	Belongs to transition
1	0.33	0.02	0.00	0.02	1.00	0.826	0.82	1.006	1.00	1.00	2.000	No
2	0.49	0.03	0.00	0.03	1.00	0.826	0.82	1.006	1.00	1.00	2.000	No
3	0.66	0.04	0.00	0.04	1.00	0.826	0.82	1.006	1.00	1.00	2.000	No
4	0.82	0.05	0.00	0.05	1.00	0.825	0.82	1.006	1.00	1.00	2.000	No
5	0.98	0.06	0.00	0.06	1.00	0.825	0.82	1.005	1.00	1.00	2.000	No
6	1.15	0.07	0.00	0.07	1.00	0.825	0.82	1.005	1.00	1.00	2.000	No
7	1.31	0.08	0.00	0.08	1.00	0.825	0.82	1.005	1.00	1.00	2.000	No
8	1.48	0.09	0.00	0.09	1.00	0.824	0.82	1.004	1.00	1.00	2.000	No
9	1.64	0.10	0.00	0.10	1.00	0.824	0.82	1.004	1.00	1.00	2.000	No
10	1.80	0.11	0.00	0.11	1.00	0.824	0.82	1.003	1.00	1.00	2.000	No
11	1.97	0.12	0.00	0.12	1.00	0.823	0.82	1.003	1.00	1.00	2.000	No
12	2.13	0.13	0.00	0.13	1.00	0.823	0.82	1.003	1.00	1.00	2.000	No
13	2.30	0.14	0.00	0.14	1.00	0.823	0.82	1.002	1.00	1.00	2.000	No
14	2.46	0.15	0.00	0.15	1.00	0.822	0.82	1.002	1.00	1.00	2.000	No
15	2.62	0.16	0.00	0.16	1.00	0.822	0.82	1.001	1.00	1.00	2.000	No
16	2.79	0.17	0.00	0.17	1.00	0.822	0.82	1.001	1.00	1.00	2.000	No
17	2.95	0.18	0.00	0.18	1.00	0.821	0.82	1.001	1.00	1.00	2.000	No
18	3.12	0.19	0.00	0.19	0.99	0.821	0.82	1.000	1.00	1.00	2.000	No
19	3.28	0.20	0.00	0.20	0.99	0.821	0.82	1.000	1.00	1.00	2.000	No
20	3.45	0.21	0.00	0.21	0.99	0.820	0.82	0.999	1.00	1.00	2.000	No
21	3.61	0.22	0.00	0.22	0.99	0.820	0.82	0.999	1.00	1.00	2.000	No
22	3.77	0.23	0.00	0.23	0.99	0.820	0.82	0.999	1.00	1.00	2.000	No
23	3.94	0.24	0.00	0.24	0.99	0.819	0.82	0.998	1.00	1.00	2.000	No
24	4.10	0.25	0.00	0.25	0.99	0.819	0.82	0.998	1.00	1.00	2.000	No
25	4.27	0.26	0.00	0.26	0.99	0.819	0.82	0.998	1.00	1.00	2.000	No
26	4.43	0.27	0.00	0.27	0.99	0.819	0.82	0.997	1.00	1.00	2.000	No
27	4.59	0.28	0.00	0.28	0.99	0.818	0.82	0.997	1.00	1.00	2.000	No
28	4.76	0.29	0.00	0.29	0.99	0.818	0.82	0.996	1.00	1.00	2.000	No
29	4.92	0.30	0.00	0.30	0.99	0.818	0.82	0.996	1.00	1.00	2.000	No
30	5.09	0.31	0.00	0.31	0.99	0.825	0.82	1.005	1.00	1.00	1.005	No
31	5.25	0.32	0.01	0.31	0.99	0.837	0.82	1.020	1.00	1.00	1.020	No
32	5.41	0.33	0.01	0.32	0.99	0.849	0.82	1.035	1.00	1.00	1.035	No
33	5.58	0.34	0.02	0.32	0.99	0.862	0.82	1.050	1.00	1.00	1.050	No
34	5.74	0.35	0.02	0.33	0.99	0.873	0.82	1.064	1.00	1.00	1.064	No
35	5.91	0.36	0.03	0.33	0.99	0.885	0.82	1.078	1.00	1.00	1.078	No
36	6.07	0.37	0.03	0.34	0.99	0.896	0.82	1.092	1.00	1.00	1.092	No
37	6.23	0.38	0.04	0.34	0.99	0.907	0.82	1.104	1.00	1.00	1.104	No
38	6.40	0.39	0.04	0.35	0.99	0.917	0.82	1.118	1.00	1.00	1.118	No
39	6.56	0.40	0.05	0.35	0.99	0.927	0.82	1.129	1.00	1.00	1.129	No
40	6.73	0.41	0.05	0.36	0.99	0.937	0.82	1.142	1.00	1.00	1.142	No
41	6.89	0.42	0.06	0.36	0.99	0.946	0.82	1.153	1.00	1.00	1.153	No
42	7.05	0.43	0.06	0.37	0.99	0.955	0.82	1.164	1.00	1.00	1.164	No
43	7.22	0.44	0.07	0.37	0.99	0.965	0.82	1.175	1.00	1.00	1.175	No
44	7.38	0.45	0.07	0.38	0.98	0.973	0.82	1.185	1.00	1.00	1.185	No
45	7.55	0.46	0.08	0.38	0.98	0.981	0.82	1.196	1.00	1.00	1.196	No
46	7.71	0.47	0.08	0.39	0.98	0.989	0.82	1.205	1.00	1.00	1.205	No
47	7.87	0.48	0.09	0.39	0.98	0.997	0.82	1.214	1.00	1.00	1.214	No
48	8.04	0.49	0.09	0.40	0.98	1.004	0.82	1.223	1.00	1.00	1.223	No

:: Cyclic Stress Ratio fully adjusted (CSR*) calculation data :: (continued)												
Point ID	Depth (ft)	σ_v (tsf)	u_0 (tsf)	σ'_v (tsf)	r_d	CSR	MSF	CSR_{eq}	K_G	User FS	CSR*	Belongs to transition
49	8.20	0.51	0.10	0.41	0.98	1.011	0.82	1.232	1.00	1.00	1.232	No
50	8.37	0.52	0.11	0.41	0.98	1.019	0.82	1.241	1.00	1.00	1.241	No
51	8.53	0.53	0.11	0.42	0.98	1.025	0.82	1.249	1.00	1.00	1.249	No
52	8.69	0.54	0.12	0.42	0.98	1.032	0.82	1.257	1.00	1.00	1.257	No
53	8.86	0.55	0.12	0.43	0.98	1.039	0.82	1.265	1.00	1.00	1.265	No
54	9.02	0.56	0.13	0.43	0.98	1.045	0.82	1.273	1.00	1.00	1.273	No
55	9.19	0.57	0.13	0.44	0.98	1.051	0.82	1.281	1.00	1.00	1.281	No
56	9.35	0.58	0.14	0.44	0.98	1.057	0.82	1.288	1.00	1.00	1.288	No
57	9.51	0.59	0.14	0.45	0.98	1.063	0.82	1.295	1.00	1.00	1.295	No
58	9.68	0.60	0.15	0.45	0.98	1.069	0.82	1.302	1.00	1.00	1.302	No
59	9.84	0.61	0.15	0.46	0.98	1.075	0.82	1.309	1.00	1.00	1.309	No
60	10.01	0.62	0.16	0.46	0.98	1.081	0.82	1.316	1.00	1.00	1.316	No
61	10.17	0.63	0.16	0.47	0.98	1.086	0.82	1.323	1.00	1.00	1.323	No
62	10.34	0.64	0.17	0.47	0.98	1.092	0.82	1.330	1.00	1.00	1.330	No
63	10.50	0.65	0.17	0.48	0.98	1.097	0.82	1.337	1.00	1.00	1.337	No
64	10.66	0.66	0.18	0.48	0.98	1.102	0.82	1.343	1.00	1.00	1.343	No
65	10.83	0.67	0.18	0.49	0.98	1.108	0.82	1.349	1.00	1.00	1.349	No
66	10.99	0.68	0.19	0.49	0.98	1.112	0.82	1.355	1.00	1.00	1.355	No
67	11.16	0.69	0.19	0.50	0.98	1.117	0.82	1.361	1.00	1.00	1.361	No
68	11.32	0.70	0.20	0.50	0.98	1.122	0.82	1.367	1.00	1.00	1.367	No
69	11.48	0.71	0.20	0.51	0.98	1.126	0.82	1.372	1.00	1.00	1.372	No
70	11.65	0.72	0.21	0.51	0.98	1.131	0.82	1.378	1.00	1.00	1.378	No
71	11.81	0.73	0.21	0.52	0.98	1.135	0.82	1.383	1.00	1.00	1.383	No
72	11.98	0.74	0.22	0.52	0.97	1.139	0.82	1.388	1.00	1.00	1.388	No
73	12.14	0.75	0.22	0.53	0.97	1.143	0.82	1.392	1.00	1.00	1.392	No
74	12.30	0.76	0.23	0.53	0.97	1.147	0.82	1.397	1.00	1.00	1.397	No
75	12.47	0.77	0.23	0.54	0.97	1.151	0.82	1.402	1.00	1.00	1.402	No
76	12.63	0.78	0.24	0.55	0.97	1.154	0.82	1.406	1.00	1.00	1.406	No
77	12.80	0.80	0.24	0.55	0.97	1.158	0.82	1.410	1.00	1.00	1.410	No
78	12.96	0.81	0.25	0.56	0.97	1.161	0.82	1.414	1.00	1.00	1.414	No
79	13.12	0.82	0.25	0.56	0.97	1.164	0.82	1.418	1.00	1.00	1.418	No
80	13.29	0.83	0.26	0.57	0.97	1.167	0.82	1.422	1.00	1.00	1.422	No
81	13.45	0.84	0.26	0.58	0.97	1.170	0.82	1.425	1.00	1.00	1.425	No
82	13.62	0.85	0.27	0.58	0.97	1.173	0.82	1.429	1.00	1.00	1.429	No
83	13.78	0.86	0.27	0.59	0.97	1.176	0.82	1.433	1.00	1.00	1.433	No
84	13.94	0.87	0.28	0.59	0.97	1.179	0.82	1.436	1.00	1.00	1.436	No
85	14.11	0.88	0.28	0.60	0.97	1.182	0.82	1.440	1.00	1.00	1.440	No
86	14.27	0.89	0.29	0.60	0.97	1.185	0.82	1.444	1.00	1.00	1.444	No
87	14.44	0.90	0.29	0.61	0.97	1.188	0.82	1.448	1.00	1.00	1.448	No
88	14.60	0.91	0.30	0.61	0.97	1.191	0.82	1.451	1.00	1.00	1.451	No
89	14.76	0.92	0.30	0.62	0.97	1.194	0.82	1.454	1.00	1.00	1.454	No
90	14.93	0.93	0.31	0.62	0.97	1.197	0.82	1.458	1.00	1.00	1.458	No
91	15.09	0.94	0.31	0.63	0.97	1.199	0.82	1.461	1.00	1.00	1.461	No
92	15.26	0.95	0.32	0.63	0.97	1.202	0.82	1.464	1.00	1.00	1.464	No
93	15.42	0.97	0.33	0.64	0.97	1.204	0.82	1.467	1.00	1.00	1.467	No
94	15.58	0.98	0.33	0.65	0.97	1.207	0.82	1.470	1.00	1.00	1.470	No
95	15.75	0.99	0.34	0.65	0.97	1.209	0.82	1.473	1.00	1.00	1.473	No
96	15.91	1.00	0.34	0.66	0.97	1.211	0.82	1.476	1.00	1.00	1.476	No

:: Cyclic Stress Ratio fully adjusted (CSR*) calculation data :: (continued)												
Point ID	Depth (ft)	σ_v (tsf)	u_0 (tsf)	σ'_v (tsf)	r_d	CSR	MSF	CSR_{eq}	K_G	User FS	CSR*	Belongs to transition
97	16.08	1.01	0.35	0.66	0.97	1.213	0.82	1.478	1.00	1.00	1.478	No
98	16.24	1.02	0.35	0.67	0.97	1.216	0.82	1.481	1.00	1.00	1.481	No
99	16.40	1.03	0.36	0.67	0.97	1.218	0.82	1.483	1.00	1.00	1.483	No
100	16.57	1.04	0.36	0.68	0.97	1.220	0.82	1.486	1.00	1.00	1.486	No
101	16.73	1.05	0.37	0.69	0.96	1.222	0.82	1.488	1.00	1.00	1.488	No
102	16.90	1.06	0.37	0.69	0.96	1.224	0.82	1.491	1.00	1.00	1.491	No
103	17.06	1.07	0.38	0.70	0.96	1.225	0.82	1.493	1.00	1.00	1.493	No
104	17.23	1.08	0.38	0.70	0.96	1.227	0.82	1.495	1.00	1.00	1.495	No
105	17.39	1.09	0.39	0.71	0.96	1.229	0.82	1.498	1.00	1.00	1.498	No
106	17.55	1.10	0.39	0.71	0.96	1.231	0.82	1.500	1.00	1.00	1.500	No
107	17.72	1.12	0.40	0.72	0.96	1.233	0.82	1.503	1.00	1.00	1.503	No
108	17.88	1.13	0.40	0.72	0.96	1.235	0.82	1.505	1.00	1.00	1.505	No
109	18.05	1.14	0.41	0.73	0.96	1.237	0.82	1.507	1.00	1.00	1.507	No
110	18.21	1.15	0.41	0.73	0.96	1.239	0.82	1.509	1.00	1.00	1.509	No
111	18.37	1.16	0.42	0.74	0.96	1.241	0.82	1.511	1.00	1.00	1.511	No
112	18.54	1.17	0.42	0.75	0.96	1.242	0.82	1.513	1.00	1.00	1.513	No
113	18.70	1.18	0.43	0.75	0.96	1.244	0.82	1.516	1.00	1.00	1.516	No
114	18.87	1.19	0.43	0.76	0.96	1.246	0.82	1.518	1.00	1.00	1.518	No
115	19.03	1.20	0.44	0.76	0.96	1.248	0.82	1.521	1.00	1.00	1.521	No
116	19.19	1.21	0.44	0.76	0.96	1.250	0.82	1.523	1.00	1.00	1.523	No
117	19.36	1.22	0.45	0.77	0.96	1.252	0.82	1.525	1.00	1.00	1.525	No
118	19.52	1.23	0.45	0.77	0.96	1.253	0.82	1.527	1.00	1.00	1.527	No
119	19.69	1.24	0.46	0.78	0.96	1.255	0.82	1.529	1.00	1.00	1.529	No
120	19.85	1.25	0.46	0.79	0.96	1.256	0.82	1.531	1.00	1.00	1.531	No
121	20.01	1.26	0.47	0.79	0.96	1.258	0.82	1.532	1.00	1.00	1.532	No
122	20.18	1.27	0.47	0.80	0.96	1.259	0.82	1.534	1.00	1.00	1.534	No
123	20.34	1.28	0.48	0.80	0.96	1.261	0.82	1.536	1.00	1.00	1.536	No
124	20.51	1.29	0.48	0.81	0.96	1.262	0.82	1.538	1.00	1.00	1.538	No
125	20.67	1.30	0.49	0.81	0.96	1.264	0.82	1.539	1.00	1.00	1.539	No
126	20.83	1.31	0.49	0.82	0.95	1.265	0.82	1.541	1.00	1.00	1.541	No
127	21.00	1.32	0.50	0.82	0.95	1.267	0.82	1.543	1.00	1.00	1.543	No
128	21.16	1.33	0.50	0.83	0.95	1.268	0.82	1.545	1.00	1.00	1.545	No
129	21.33	1.34	0.51	0.83	0.95	1.269	0.82	1.546	1.00	1.00	1.546	No
130	21.49	1.35	0.51	0.84	0.95	1.270	0.82	1.547	1.00	1.00	1.547	No
131	21.65	1.36	0.52	0.84	0.95	1.271	0.82	1.549	1.00	1.00	1.549	No
132	21.82	1.37	0.52	0.85	0.95	1.272	0.82	1.550	1.00	1.00	1.550	No
133	21.98	1.38	0.53	0.85	0.95	1.273	0.82	1.551	1.00	1.00	1.551	No
134	22.15	1.39	0.54	0.86	0.95	1.274	0.82	1.553	1.00	1.00	1.553	No
135	22.31	1.40	0.54	0.86	0.95	1.275	0.82	1.554	1.00	1.00	1.554	No
136	22.47	1.41	0.55	0.87	0.95	1.276	0.82	1.555	1.00	1.00	1.555	No
137	22.64	1.42	0.55	0.87	0.95	1.277	0.82	1.556	1.00	1.00	1.556	No
138	22.80	1.43	0.56	0.88	0.95	1.278	0.82	1.557	1.00	1.00	1.557	No
139	22.97	1.45	0.56	0.89	0.95	1.279	0.82	1.558	1.00	1.00	1.558	No
140	23.13	1.46	0.57	0.89	0.95	1.280	0.82	1.559	1.00	1.00	1.559	No
141	23.30	1.47	0.57	0.90	0.95	1.281	0.82	1.560	1.00	1.00	1.560	No
142	23.46	1.48	0.58	0.90	0.95	1.281	0.82	1.561	1.00	1.00	1.561	No
143	23.62	1.49	0.58	0.91	0.95	1.282	0.82	1.562	1.00	1.00	1.562	No
144	23.79	1.50	0.59	0.91	0.95	1.283	0.82	1.563	1.00	1.00	1.563	No

:: Cyclic Stress Ratio fully adjusted (CSR*) calculation data :: (continued)												
Point ID	Depth (ft)	σ_v (tsf)	u_0 (tsf)	σ'_v (tsf)	r_d	CSR	MSF	CSR_{eq}	K_G	User FS	CSR*	Belongs to transition
145	23.95	1.51	0.59	0.92	0.95	1.284	0.82	1.564	1.00	1.00	1.564	No
146	24.12	1.52	0.60	0.92	0.94	1.285	0.82	1.565	1.00	1.00	1.565	No
147	24.28	1.53	0.60	0.93	0.94	1.285	0.82	1.566	1.00	1.00	1.566	No
148	24.44	1.54	0.61	0.93	0.94	1.286	0.82	1.567	1.00	1.00	1.567	No
149	24.61	1.55	0.61	0.94	0.94	1.287	0.82	1.567	1.00	1.00	1.567	No
150	24.77	1.56	0.62	0.94	0.94	1.287	0.82	1.568	1.00	1.00	1.568	No
151	24.94	1.57	0.62	0.95	0.94	1.288	0.82	1.569	1.00	1.00	1.569	No
152	25.10	1.58	0.63	0.95	0.94	1.288	0.82	1.570	1.00	1.00	1.570	No
153	25.26	1.59	0.63	0.96	0.94	1.289	0.82	1.570	1.00	1.00	1.570	No
154	25.43	1.60	0.64	0.96	0.94	1.289	0.82	1.570	1.00	1.00	1.570	No
155	25.59	1.61	0.64	0.97	0.94	1.289	0.82	1.571	1.00	1.00	1.571	No
156	25.76	1.62	0.65	0.98	0.94	1.290	0.82	1.571	1.00	1.00	1.571	No
157	25.92	1.63	0.65	0.98	0.94	1.290	0.82	1.571	1.00	1.00	1.571	No
158	26.08	1.64	0.66	0.99	0.94	1.290	0.82	1.571	1.00	1.00	1.571	No
159	26.25	1.66	0.66	0.99	0.94	1.290	0.82	1.572	1.00	1.00	1.572	No
160	26.41	1.67	0.67	1.00	0.94	1.290	0.82	1.572	1.00	1.00	1.572	No
161	26.58	1.68	0.67	1.00	0.94	1.290	0.82	1.572	1.00	1.00	1.572	No
162	26.74	1.69	0.68	1.01	0.94	1.290	0.82	1.572	1.00	1.00	1.572	No
163	26.90	1.70	0.68	1.02	0.93	1.290	0.82	1.572	1.00	1.00	1.572	No
164	27.07	1.71	0.69	1.02	0.93	1.290	0.82	1.572	1.00	1.00	1.572	No
165	27.23	1.72	0.69	1.03	0.93	1.290	0.82	1.572	1.00	1.00	1.572	No
166	27.40	1.73	0.70	1.03	0.93	1.290	0.82	1.572	1.00	1.00	1.572	No
167	27.56	1.74	0.70	1.04	0.93	1.290	0.82	1.572	1.00	1.00	2.000	Yes
168	27.72	1.75	0.71	1.04	0.93	1.290	0.82	1.572	1.00	1.00	2.000	Yes
169	27.89	1.76	0.71	1.05	0.93	1.290	0.82	1.572	1.00	1.00	2.000	Yes
170	28.05	1.77	0.72	1.06	0.93	1.291	0.82	1.572	1.00	1.00	2.000	Yes
171	28.22	1.79	0.72	1.06	0.93	1.291	0.82	1.572	1.00	1.00	2.000	Yes
172	28.38	1.80	0.73	1.07	0.93	1.291	0.82	1.573	1.00	1.00	2.000	Yes
173	28.54	1.80	0.73	1.07	0.93	1.291	0.82	1.573	1.00	1.00	2.000	Yes
174	28.71	1.81	0.74	1.08	0.93	1.292	0.82	1.573	1.00	1.00	2.000	Yes
175	28.87	1.82	0.74	1.08	0.93	1.292	0.82	1.574	1.00	1.00	2.000	Yes
176	29.04	1.83	0.75	1.08	0.93	1.293	0.82	1.575	1.00	1.00	2.000	Yes
177	29.20	1.84	0.76	1.09	0.92	1.294	0.82	1.576	1.00	1.00	2.000	Yes
178	29.36	1.85	0.76	1.09	0.92	1.295	0.82	1.577	1.00	1.00	2.000	Yes
179	29.53	1.86	0.77	1.09	0.92	1.295	0.82	1.578	1.00	1.00	2.000	Yes
180	29.69	1.87	0.77	1.10	0.92	1.296	0.82	1.578	1.00	1.00	2.000	Yes
181	29.86	1.88	0.78	1.10	0.92	1.296	0.82	1.579	1.00	1.00	2.000	Yes
182	30.02	1.89	0.78	1.11	0.92	1.296	0.82	1.579	1.00	1.00	2.000	Yes
183	30.19	1.90	0.79	1.11	0.92	1.296	0.82	1.579	1.00	1.00	2.000	Yes
184	30.35	1.91	0.79	1.12	0.92	1.296	0.82	1.579	1.00	1.00	2.000	Yes
185	30.51	1.92	0.80	1.12	0.92	1.296	0.82	1.578	1.00	1.00	1.578	No
186	30.68	1.93	0.80	1.13	0.92	1.295	0.82	1.578	1.00	1.00	1.578	No
187	30.84	1.94	0.81	1.13	0.92	1.295	0.82	1.578	1.00	1.00	1.578	No
188	31.01	1.95	0.81	1.14	0.92	1.295	0.82	1.577	1.00	1.00	1.577	No
189	31.17	1.96	0.82	1.14	0.91	1.295	0.82	1.577	1.00	1.00	1.577	No
190	31.33	1.97	0.82	1.15	0.91	1.295	0.82	1.577	1.00	1.00	1.577	No
191	31.50	1.98	0.83	1.15	0.91	1.294	0.82	1.577	1.00	1.00	1.577	No
192	31.66	1.99	0.83	1.16	0.91	1.294	0.82	1.576	1.00	1.00	1.576	No

:: Cyclic Stress Ratio fully adjusted (CSR*) calculation data :: (continued)

Point ID	Depth (ft)	σ_v (tsf)	u_0 (tsf)	σ'_v (tsf)	r_d	CSR	MSF	CSR_{eq}	K_G	User FS	CSR*	Belongs to transition
193	31.83	2.00	0.84	1.16	0.91	1.294	0.82	1.576	1.00	1.00	1.576	No
194	31.99	2.01	0.84	1.17	0.91	1.293	0.82	1.575	1.00	1.00	1.575	No
195	32.15	2.02	0.85	1.17	0.91	1.293	0.82	1.575	1.00	1.00	1.575	No
196	32.32	2.03	0.85	1.18	0.91	1.292	0.82	1.574	1.00	1.00	1.574	No
197	32.48	2.04	0.86	1.18	0.91	1.291	0.82	1.573	1.00	1.00	1.573	No
198	32.65	2.05	0.86	1.19	0.91	1.291	0.82	1.572	1.00	1.00	1.572	No
199	32.81	2.06	0.87	1.19	0.90	1.290	0.82	1.572	1.00	1.00	2.000	Yes
200	32.97	2.07	0.87	1.20	0.90	1.290	0.82	1.571	1.00	1.00	2.000	Yes
201	33.14	2.08	0.88	1.20	0.90	1.289	0.82	1.570	1.00	1.00	2.000	Yes
202	33.30	2.09	0.88	1.21	0.90	1.288	0.82	1.569	1.00	1.00	2.000	Yes
203	33.47	2.10	0.89	1.21	0.90	1.288	0.82	1.569	1.00	1.00	2.000	Yes
204	33.63	2.11	0.89	1.22	0.90	1.287	0.82	1.568	1.00	1.00	1.568	No
205	33.79	2.12	0.90	1.22	0.90	1.286	0.82	1.567	1.00	1.00	1.567	No
206	33.96	2.13	0.90	1.23	0.90	1.286	0.82	1.566	1.00	1.00	2.000	Yes
207	34.12	2.14	0.91	1.23	0.90	1.285	0.82	1.565	1.00	1.00	2.000	Yes
208	34.29	2.15	0.91	1.24	0.90	1.284	0.82	1.564	1.00	1.00	2.000	Yes
209	34.45	2.16	0.92	1.24	0.89	1.284	0.82	1.564	1.00	1.00	2.000	Yes
210	34.61	2.17	0.92	1.25	0.89	1.283	0.82	1.563	1.00	1.00	2.000	Yes
211	34.78	2.18	0.93	1.26	0.89	1.282	0.82	1.561	1.00	1.00	2.000	Yes
212	34.94	2.19	0.93	1.26	0.89	1.281	0.82	1.560	1.00	1.00	2.000	Yes
213	35.11	2.21	0.94	1.27	0.89	1.279	0.82	1.559	1.00	1.00	2.000	Yes
214	35.27	2.22	0.94	1.27	0.89	1.278	0.82	1.557	1.00	1.00	1.557	No
215	35.43	2.23	0.95	1.28	0.89	1.277	0.82	1.556	1.00	1.00	1.556	No
216	35.60	2.24	0.95	1.28	0.89	1.276	0.82	1.554	1.00	1.00	1.554	No
217	35.76	2.25	0.96	1.29	0.89	1.274	0.82	1.552	1.00	1.00	1.552	No
218	35.93	2.26	0.97	1.30	0.88	1.273	0.82	1.551	1.00	1.00	1.551	No
219	36.09	2.27	0.97	1.30	0.88	1.272	0.82	1.549	1.00	1.00	1.549	No
220	36.26	2.28	0.98	1.31	0.88	1.270	0.82	1.547	1.00	1.00	1.547	No
221	36.42	2.29	0.98	1.31	0.88	1.269	0.82	1.546	1.00	1.00	1.546	No
222	36.58	2.31	0.99	1.32	0.88	1.267	0.82	1.544	1.00	1.00	1.544	No
223	36.75	2.32	0.99	1.33	0.88	1.266	0.82	1.542	1.00	1.00	1.542	No
224	36.91	2.33	1.00	1.33	0.88	1.264	0.82	1.540	1.00	1.00	1.540	No
225	37.08	2.34	1.00	1.34	0.88	1.263	0.82	1.538	1.00	1.00	1.538	No
226	37.24	2.35	1.01	1.34	0.87	1.261	0.82	1.537	1.00	1.00	1.537	No
227	37.40	2.36	1.01	1.35	0.87	1.260	0.82	1.535	1.00	1.00	1.535	No
228	37.57	2.37	1.02	1.36	0.87	1.258	0.82	1.533	1.00	1.00	1.533	No
229	37.73	2.38	1.02	1.36	0.87	1.257	0.82	1.531	1.00	1.00	1.531	No
230	37.90	2.40	1.03	1.37	0.87	1.255	0.82	1.529	1.00	1.00	1.529	No
231	38.06	2.41	1.03	1.38	0.87	1.253	0.82	1.527	1.00	1.00	1.527	No
232	38.22	2.42	1.04	1.38	0.87	1.252	0.82	1.525	1.00	1.00	1.525	No
233	38.39	2.43	1.04	1.39	0.86	1.250	0.82	1.523	1.00	1.00	1.523	No
234	38.55	2.44	1.05	1.39	0.86	1.248	0.82	1.521	1.00	1.00	1.521	No
235	38.72	2.45	1.05	1.40	0.86	1.246	0.82	1.518	1.00	1.00	1.518	No
236	38.88	2.46	1.06	1.41	0.86	1.245	0.82	1.516	1.00	1.00	1.516	No
237	39.04	2.47	1.06	1.41	0.86	1.243	0.82	1.514	1.00	1.00	1.514	No
238	39.21	2.49	1.07	1.42	0.86	1.241	0.82	1.512	1.00	1.00	1.512	No
239	39.37	2.50	1.07	1.42	0.86	1.239	0.82	1.510	1.00	1.00	1.510	No
240	39.54	2.51	1.08	1.43	0.86	1.238	0.82	1.508	1.00	1.00	1.508	No

:: Cyclic Stress Ratio fully adjusted (CSR*) calculation data :: (continued)

Point ID	Depth (ft)	σ_v (tsf)	u_0 (tsf)	σ'_v (tsf)	r_d	CSR	MSF	CSR_{eq}	K_G	User FS	CSR*	Belongs to transition
241	39.70	2.52	1.08	1.44	0.85	1.236	0.82	1.506	1.00	1.00	1.506	No
242	39.86	2.53	1.09	1.44	0.85	1.234	0.82	1.504	1.00	1.00	1.504	No
243	40.03	2.54	1.09	1.45	0.85	1.232	0.82	1.501	1.00	1.00	1.501	No
244	40.19	2.55	1.10	1.45	0.85	1.231	0.82	1.499	1.00	1.00	1.499	No
245	40.36	2.56	1.10	1.46	0.85	1.229	0.82	1.497	1.00	1.00	1.497	No
246	40.52	2.57	1.11	1.47	0.85	1.227	0.82	1.495	1.00	1.00	1.495	No
247	40.68	2.58	1.11	1.47	0.84	1.225	0.82	1.493	1.00	1.00	1.493	No
248	40.85	2.60	1.12	1.48	0.84	1.224	0.82	1.491	1.00	1.00	2.000	Yes
249	41.01	2.61	1.12	1.48	0.84	1.222	0.82	1.488	1.00	1.00	2.000	Yes
250	41.18	2.62	1.13	1.49	0.84	1.220	0.82	1.486	1.00	1.00	2.000	Yes
251	41.34	2.63	1.13	1.49	0.84	1.218	0.82	1.484	1.00	1.00	2.000	Yes
252	41.50	2.64	1.14	1.50	0.84	1.217	0.82	1.482	1.00	1.00	1.482	No
253	41.67	2.65	1.14	1.50	0.84	1.215	0.82	1.481	1.00	1.00	1.481	No
254	41.83	2.66	1.15	1.51	0.83	1.214	0.82	1.479	1.00	1.00	1.479	No
255	42.00	2.67	1.15	1.51	0.83	1.213	0.82	1.477	1.00	1.00	1.477	No
256	42.16	2.68	1.16	1.52	0.83	1.211	0.82	1.475	1.00	1.00	1.475	No
257	42.32	2.68	1.16	1.52	0.83	1.210	0.82	1.474	1.00	1.00	1.474	No
258	42.49	2.69	1.17	1.52	0.83	1.208	0.82	1.472	1.00	1.00	1.472	No
259	42.65	2.70	1.17	1.53	0.83	1.207	0.82	1.470	1.00	1.00	1.470	No
260	42.82	2.71	1.18	1.53	0.83	1.205	0.82	1.468	1.00	1.00	1.468	No
261	42.98	2.72	1.18	1.54	0.82	1.204	0.82	1.466	1.00	1.00	1.466	No
262	43.15	2.73	1.19	1.54	0.82	1.202	0.82	1.464	1.00	1.00	1.464	No
263	43.31	2.74	1.20	1.55	0.82	1.200	0.82	1.462	1.00	1.00	1.462	No
264	43.47	2.75	1.20	1.55	0.82	1.199	0.82	1.460	1.00	1.00	1.460	No
265	43.64	2.76	1.21	1.56	0.82	1.197	0.82	1.458	1.00	1.00	1.458	No
266	43.80	2.77	1.21	1.56	0.82	1.196	0.82	1.456	1.00	1.00	1.456	No
267	43.97	2.78	1.22	1.56	0.81	1.194	0.82	1.454	1.00	1.00	1.454	No
268	44.13	2.79	1.22	1.57	0.81	1.192	0.82	1.452	1.00	1.00	1.452	No
269	44.29	2.80	1.23	1.57	0.81	1.191	0.82	1.451	1.00	1.00	1.451	No
270	44.46	2.81	1.23	1.58	0.81	1.189	0.82	1.448	1.00	1.00	1.448	No
271	44.62	2.82	1.24	1.58	0.81	1.187	0.82	1.446	1.00	1.00	1.446	No
272	44.79	2.83	1.24	1.59	0.81	1.185	0.82	1.444	1.00	1.00	1.444	No
273	44.95	2.84	1.25	1.59	0.80	1.184	0.82	1.442	1.00	1.00	1.442	No
274	45.11	2.85	1.25	1.60	0.80	1.182	0.82	1.440	1.00	1.00	1.440	No
275	45.28	2.86	1.26	1.60	0.80	1.180	0.82	1.438	1.00	1.00	1.438	No
276	45.44	2.87	1.26	1.60	0.80	1.179	0.82	1.436	1.00	1.00	2.000	Yes
277	45.61	2.88	1.27	1.61	0.80	1.177	0.82	1.433	1.00	1.00	2.000	Yes
278	45.77	2.89	1.27	1.61	0.80	1.175	0.82	1.431	1.00	1.00	2.000	Yes
279	45.93	2.90	1.28	1.62	0.79	1.172	0.82	1.428	1.00	1.00	2.000	Yes
280	46.10	2.91	1.28	1.63	0.79	1.170	0.82	1.426	1.00	1.00	2.000	Yes
281	46.26	2.92	1.29	1.63	0.79	1.168	0.82	1.423	1.00	1.00	1.423	No
282	46.43	2.93	1.29	1.64	0.79	1.166	0.82	1.420	1.00	1.00	1.420	No
283	46.59	2.94	1.30	1.64	0.79	1.163	0.82	1.417	1.00	1.00	1.417	No
284	46.75	2.95	1.30	1.65	0.79	1.161	0.82	1.415	1.00	1.00	1.415	No
285	46.92	2.96	1.31	1.66	0.78	1.159	0.82	1.412	1.00	1.00	1.412	No
286	47.08	2.97	1.31	1.66	0.78	1.156	0.82	1.409	1.00	1.00	1.409	No
287	47.25	2.99	1.32	1.67	0.78	1.154	0.82	1.406	1.00	1.00	1.406	No
288	47.41	3.00	1.32	1.67	0.78	1.152	0.82	1.403	1.00	1.00	1.403	No

:: Cyclic Stress Ratio fully adjusted (CSR*) calculation data :: (continued)

Point ID	Depth (ft)	σ_v (tsf)	u_0 (tsf)	σ_v' (tsf)	r_d	CSR	MSF	CSR_{eq}	K_σ	User FS	CSR^*	Belongs to transition
289	47.57	3.01	1.33	1.68	0.78	1.149	0.82	1.400	1.00	1.00	1.400	No
290	47.74	3.02	1.33	1.69	0.78	1.147	0.82	1.397	1.00	1.00	1.397	No
291	47.90	3.03	1.34	1.69	0.77	1.145	0.82	1.395	1.00	1.00	1.395	No
292	48.07	3.04	1.34	1.70	0.77	1.142	0.82	1.392	1.00	1.00	1.392	No
293	48.23	3.05	1.35	1.70	0.77	1.140	0.82	1.389	1.00	1.00	1.389	No
294	48.39	3.06	1.35	1.71	0.77	1.138	0.82	1.386	1.00	1.00	1.386	No
295	48.56	3.08	1.36	1.72	0.77	1.135	0.82	1.383	1.00	1.00	1.383	No
296	48.72	3.09	1.36	1.72	0.77	1.133	0.82	1.380	1.00	1.00	1.380	No
297	48.89	3.10	1.37	1.73	0.76	1.130	0.82	1.377	1.00	1.00	1.377	No
298	49.05	3.11	1.37	1.73	0.76	1.128	0.82	1.374	1.00	1.00	1.374	No
299	49.22	3.12	1.38	1.74	0.76	1.126	0.82	1.371	1.00	1.00	1.371	No
300	49.38	3.13	1.38	1.75	0.76	1.123	0.82	1.369	1.00	1.00	1.369	No

Abbreviations

Depth:	Depth from free surface, at which CPT was performed (ft)
σ_v :	Total overburden pressure at test point (tsf)
u_0 :	Water pressure at test point (tsf)
σ_v' :	Effective overburden pressure based on GWT during earthquake (tsf)
r_d :	Nonlinear shear mass factor
CSR:	Cyclic Stress Ratio
MSF:	Magnitude Scaling Factor
CSR_{eq} :	CSR adjusted for M=7.5
K_σ :	Effective overburden stress factor
CSR^* :	CSR fully adjusted

:: Cyclic Resistance Ratio (CRR) calculation data ::

Point ID	Depth (ft)	q_t (tsf)	I_c	Fr (%)	n	Q_{tn}	K_c	$Q_{tn,cs}$	CRR _{7.5}	Belongs to trans. layer	Clay-like behaviour	FS
1	0.33	12.50	2.95	7.21	0.98	23.59	6.23	146.95	4.000	No	Yes	2.00
2	0.49	68.37	1.95	1.51	0.59	129.17	1.24	160.25	4.000	No	No	2.00
3	0.66	116.07	1.66	1.01	0.49	219.31	1.01	222.20	4.000	No	No	2.00
4	0.82	161.24	1.45	0.70	0.41	304.68	1.00	304.68	4.000	No	No	2.00
5	0.98	145.95	1.47	0.69	0.41	275.75	1.00	275.75	4.000	No	No	2.00
6	1.15	136.88	1.46	0.61	0.41	258.60	1.00	258.60	4.000	No	No	2.00
7	1.31	128.98	1.46	0.57	0.41	243.65	1.00	243.65	4.000	No	No	2.00
8	1.48	125.05	1.46	0.56	0.41	236.20	1.00	236.20	4.000	No	No	2.00
9	1.64	125.16	1.48	0.59	0.42	236.38	1.00	236.38	4.000	No	No	2.00
10	1.80	130.79	1.47	0.61	0.42	247.02	1.00	247.02	4.000	No	No	2.00
11	1.97	142.27	1.45	0.61	0.41	268.68	1.00	268.68	4.000	No	No	2.00
12	2.13	163.54	1.38	0.57	0.38	308.88	1.00	308.88	4.000	No	No	2.00
13	2.30	195.95	1.32	0.56	0.36	370.12	1.00	370.12	4.000	No	No	2.00
14	2.46	232.23	1.29	0.59	0.35	435.52	1.00	435.52	4.000	No	No	2.00
15	2.62	257.96	1.30	0.65	0.35	476.00	1.00	476.00	4.000	No	No	2.00
16	2.79	268.39	1.32	0.70	0.36	490.39	1.00	490.39	4.000	No	No	2.00
17	2.95	268.58	1.33	0.72	0.37	485.70	1.00	485.70	4.000	No	No	2.00
18	3.12	263.78	1.34	0.72	0.37	470.08	1.00	470.08	4.000	No	No	2.00
19	3.28	257.98	1.34	0.70	0.37	451.41	1.00	451.41	4.000	No	No	2.00
20	3.45	250.98	1.34	0.68	0.37	430.42	1.00	430.42	4.000	No	No	2.00
21	3.61	240.25	1.35	0.67	0.38	407.42	1.00	407.42	4.000	No	No	2.00
22	3.77	223.41	1.38	0.67	0.38	377.95	1.00	377.95	4.000	No	No	2.00
23	3.94	200.25	1.41	0.68	0.40	339.88	1.00	339.88	4.000	No	No	2.00
24	4.10	176.41	1.45	0.68	0.41	300.51	1.00	300.51	4.000	No	No	2.00
25	4.27	155.31	1.48	0.67	0.43	264.68	1.00	264.68	4.000	No	No	2.00
26	4.43	138.54	1.49	0.60	0.43	233.66	1.00	233.66	4.000	No	No	2.00
27	4.59	129.10	1.50	0.57	0.43	215.67	1.00	215.67	4.000	No	No	2.00
28	4.76	123.34	1.50	0.54	0.44	203.54	1.00	203.54	4.000	No	No	2.00
29	4.92	117.71	1.54	0.60	0.45	195.35	1.00	195.35	4.000	No	No	2.00
30	5.09	112.77	1.57	0.62	0.46	187.45	1.00	187.45	0.693	No	No	0.69
31	5.25	108.77	1.59	0.65	0.47	181.37	1.00	181.37	0.635	No	No	0.62
32	5.41	107.54	1.57	0.59	0.46	176.83	1.00	176.83	0.594	No	No	0.57
33	5.58	105.91	1.57	0.57	0.46	172.77	1.00	172.77	0.560	No	No	0.53
34	5.74	106.34	1.57	0.57	0.46	172.39	1.00	172.39	0.556	No	No	0.52
35	5.91	107.07	1.61	0.66	0.48	175.14	1.00	175.14	0.580	No	No	0.54
36	6.07	112.16	1.61	0.69	0.48	182.29	1.00	182.29	0.643	No	No	0.59
37	6.23	117.42	1.60	0.71	0.48	189.51	1.00	189.51	0.713	No	No	0.65
38	6.40	123.39	1.59	0.70	0.47	196.59	1.00	196.59	0.787	No	No	0.70
39	6.56	128.66	1.60	0.75	0.47	204.38	1.00	204.38	4.000	No	No	2.00
40	6.73	137.80	1.60	0.80	0.47	217.40	1.00	217.40	4.000	No	No	2.00
41	6.89	151.77	1.58	0.84	0.47	236.80	1.00	236.80	4.000	No	No	2.00
42	7.05	165.77	1.56	0.83	0.46	254.47	1.00	254.47	4.000	No	No	2.00
43	7.22	171.81	1.56	0.86	0.46	262.29	1.00	262.29	4.000	No	No	2.00
44	7.38	186.33	1.55	0.90	0.46	282.12	1.00	282.12	4.000	No	No	2.00
45	7.55	214.29	1.54	0.97	0.46	321.07	1.00	321.07	4.000	No	No	2.00
46	7.71	259.94	1.50	0.96	0.44	380.47	1.00	380.47	4.000	No	No	2.00
47	7.87	290.65	1.47	0.96	0.43	419.16	1.00	419.16	4.000	No	No	2.00
48	8.04	289.92	1.47	0.96	0.43	415.38	1.00	415.38	4.000	No	No	2.00

:: Cyclic Resistance Ratio (CRR) calculation data :: (continued)												
Point ID	Depth (ft)	q _t (tsf)	I _c	Fr (%)	n	Q _{tn}	K _c	Q _{tn,cs}	CRR _{7.5}	Belongs to trans. layer	Clay-like behaviour	FS
49	8.20	266.82	1.49	0.95	0.44	382.75	1.00	382.75	4.000	No	No	2.00
50	8.37	243.14	1.51	0.95	0.45	349.50	1.00	349.50	4.000	No	No	2.00
51	8.53	233.71	1.53	0.96	0.45	335.73	1.00	335.73	4.000	No	No	2.00
52	8.69	229.86	1.53	0.94	0.45	328.49	1.00	328.49	4.000	No	No	2.00
53	8.86	225.40	1.52	0.90	0.45	319.45	1.00	319.45	4.000	No	No	2.00
54	9.02	222.12	1.51	0.84	0.44	311.36	1.00	311.36	4.000	No	No	2.00
55	9.19	216.76	1.52	0.85	0.45	303.16	1.00	303.16	4.000	No	No	2.00
56	9.35	209.17	1.52	0.83	0.45	291.46	1.00	291.46	4.000	No	No	2.00
57	9.51	187.04	1.56	0.86	0.47	262.70	1.00	262.70	4.000	No	No	2.00
58	9.68	153.64	1.64	0.94	0.50	220.09	1.00	219.30	4.000	No	No	2.00
59	9.84	109.50	1.83	1.29	0.57	165.28	1.13	186.09	0.679	No	No	0.52
60	10.01	84.06	1.94	1.48	0.61	130.49	1.23	160.45	0.464	No	No	0.35
61	10.17	80.87	1.91	1.25	0.60	123.40	1.19	147.37	0.378	No	No	0.29
62	10.34	95.57	1.75	0.84	0.54	138.53	1.07	148.85	0.387	No	No	0.29
63	10.50	107.38	1.69	0.75	0.52	152.00	1.03	156.78	0.438	No	No	0.33
64	10.66	116.63	1.68	0.78	0.51	163.66	1.02	167.20	0.515	No	No	0.38
65	10.83	129.16	1.65	0.78	0.50	178.92	1.00	179.28	0.616	No	No	0.46
66	10.99	145.36	1.60	0.74	0.48	197.73	1.00	197.73	0.799	No	No	0.59
67	11.16	162.96	1.56	0.72	0.47	218.24	1.00	218.24	4.000	No	No	2.00
68	11.32	180.62	1.53	0.70	0.46	238.57	1.00	238.57	4.000	No	No	2.00
69	11.48	199.14	1.50	0.71	0.45	260.08	1.00	260.08	4.000	No	No	2.00
70	11.65	216.40	1.48	0.70	0.44	279.38	1.00	279.38	4.000	No	No	2.00
71	11.81	232.82	1.47	0.72	0.43	298.59	1.00	298.59	4.000	No	No	2.00
72	11.98	247.84	1.45	0.73	0.43	315.53	1.00	315.53	4.000	No	No	2.00
73	12.14	263.20	1.45	0.75	0.43	333.18	1.00	333.18	4.000	No	No	2.00
74	12.30	279.13	1.43	0.73	0.42	349.91	1.00	349.91	4.000	No	No	2.00
75	12.47	292.53	1.42	0.74	0.42	364.62	1.00	364.62	4.000	No	No	2.00
76	12.63	298.60	1.43	0.77	0.42	371.46	1.00	371.46	4.000	No	No	2.00
77	12.80	294.23	1.50	0.97	0.45	371.41	1.00	371.41	4.000	No	No	2.00
78	12.96	270.99	1.64	1.36	0.50	351.80	1.00	351.80	4.000	No	No	2.00
79	13.12	224.58	1.80	1.92	0.56	301.49	1.11	333.80	4.000	No	No	2.00
80	13.29	165.78	1.99	2.71	0.63	230.99	1.29	296.96	4.000	No	No	2.00
81	13.45	113.04	2.19	3.77	0.71	163.72	1.65	269.76	4.000	No	No	2.00
82	13.62	88.95	2.31	4.50	0.76	131.15	1.98	260.05	4.000	No	No	2.00
83	13.78	85.05	2.31	4.36	0.76	124.51	1.99	247.56	4.000	No	No	2.00
84	13.94	95.19	2.20	3.39	0.72	135.27	1.68	226.73	4.000	No	No	2.00
85	14.11	112.28	2.05	2.36	0.66	153.35	1.37	209.49	4.000	No	No	2.00
86	14.27	139.79	1.85	1.51	0.58	182.27	1.14	208.66	4.000	No	No	2.00
87	14.44	172.27	1.68	1.05	0.52	215.96	1.03	221.56	4.000	No	No	2.00
88	14.60	198.40	1.59	0.88	0.48	243.12	1.00	243.12	4.000	No	No	2.00
89	14.76	215.56	1.55	0.84	0.47	261.27	1.00	261.27	4.000	No	No	2.00
90	14.93	228.36	1.49	0.72	0.45	272.33	1.00	272.33	4.000	No	No	2.00
91	15.09	240.78	1.48	0.71	0.44	285.15	1.00	285.15	4.000	No	No	2.00
92	15.26	253.07	1.48	0.75	0.44	298.94	1.00	298.94	4.000	No	No	2.00
93	15.42	259.31	1.54	0.92	0.47	308.46	1.00	308.46	4.000	No	No	2.00
94	15.58	263.15	1.56	1.00	0.48	313.39	1.00	313.39	4.000	No	No	2.00
95	15.75	265.45	1.57	1.02	0.48	315.06	1.00	315.06	4.000	No	No	2.00
96	15.91	268.77	1.56	1.02	0.48	317.63	1.00	317.63	4.000	No	No	2.00

:: Cyclic Resistance Ratio (CRR) calculation data :: (continued)												
Point ID	Depth (ft)	q_t (tsf)	I_c	Fr (%)	n	Q_{tn}	K_c	$Q_{tn,cs}$	CRR _{7.5}	Belongs to trans. layer	Clay-like behaviour	FS
97	16.08	270.59	1.57	1.04	0.48	318.75	1.00	318.75	4.000	No	No	2.00
98	16.24	272.15	1.58	1.08	0.48	320.07	1.00	320.07	4.000	No	No	2.00
99	16.40	269.35	1.60	1.12	0.49	316.30	1.00	316.30	4.000	No	No	2.00
100	16.57	260.98	1.61	1.14	0.50	305.97	1.00	305.97	4.000	No	No	2.00
101	16.73	253.41	1.63	1.18	0.50	296.78	1.00	296.78	4.000	No	No	2.00
102	16.90	256.51	1.62	1.14	0.50	298.50	1.00	298.50	4.000	No	No	2.00
103	17.06	261.11	1.58	1.04	0.49	301.12	1.00	301.12	4.000	No	No	2.00
104	17.23	249.54	1.57	0.94	0.48	285.75	1.00	285.75	4.000	No	No	2.00
105	17.39	225.37	1.55	0.80	0.47	256.29	1.00	256.29	4.000	No	No	2.00
106	17.55	212.70	1.53	0.71	0.47	240.32	1.00	240.32	4.000	No	No	2.00
107	17.72	220.00	1.47	0.59	0.44	245.58	1.00	245.58	4.000	No	No	2.00
108	17.88	236.02	1.46	0.62	0.44	262.51	1.00	262.51	4.000	No	No	2.00
109	18.05	245.51	1.48	0.70	0.45	273.02	1.00	273.02	4.000	No	No	2.00
110	18.21	237.46	1.55	0.85	0.48	265.76	1.00	265.76	4.000	No	No	2.00
111	18.37	202.72	1.69	1.12	0.53	230.08	1.03	236.64	4.000	No	No	2.00
112	18.54	143.31	1.90	1.62	0.61	166.26	1.19	197.35	0.795	No	No	0.53
113	18.70	82.79	2.17	2.37	0.71	98.56	1.60	158.01	0.447	No	No	0.29
114	18.87	44.12	2.44	3.11	0.82	53.42	2.50	133.32	0.300	No	No	0.20
115	19.03	34.64	2.47	2.59	0.83	41.56	2.62	108.74	0.200	No	No	0.13
116	19.19	63.79	2.09	1.33	0.68	73.85	1.44	106.26	0.192	No	No	0.13
117	19.36	115.68	1.83	1.02	0.58	130.25	1.13	146.98	0.375	No	No	0.25
118	19.52	171.31	1.68	0.92	0.53	189.45	1.02	194.14	0.760	No	No	0.50
119	19.69	207.47	1.61	0.89	0.50	227.12	1.00	227.12	4.000	No	No	2.00
120	19.85	220.51	1.58	0.85	0.49	239.86	1.00	239.86	4.000	No	No	2.00
121	20.01	219.04	1.56	0.78	0.48	236.88	1.00	236.88	4.000	No	No	2.00
122	20.18	197.34	1.62	0.87	0.51	214.03	1.00	214.03	4.000	No	No	2.00
123	20.34	159.47	1.72	0.97	0.54	173.93	1.05	183.17	0.652	No	No	0.42
124	20.51	108.87	1.95	1.39	0.63	120.63	1.24	149.13	0.388	No	No	0.25
125	20.67	64.53	2.19	1.85	0.72	72.42	1.65	119.15	0.237	No	No	0.15
126	20.83	50.78	2.34	2.36	0.78	57.26	2.08	118.98	0.237	No	No	0.15
127	21.00	83.61	2.07	1.58	0.68	92.33	1.40	129.22	0.281	No	No	0.18
128	21.16	134.42	1.84	1.20	0.59	145.61	1.14	165.94	0.505	No	No	0.33
129	21.33	175.70	1.68	0.92	0.53	187.26	1.03	192.20	0.740	No	No	0.48
130	21.49	182.05	1.67	0.92	0.53	193.30	1.02	197.31	0.794	No	No	0.51
131	21.65	169.14	1.75	1.09	0.56	180.06	1.07	192.83	0.747	No	No	0.48
132	21.82	159.18	1.83	1.33	0.59	169.89	1.13	191.65	0.735	No	No	0.47
133	21.98	165.41	1.82	1.32	0.58	175.78	1.12	196.63	0.787	No	No	0.51
134	22.15	182.34	1.75	1.18	0.56	192.22	1.07	206.45	4.000	No	No	2.00
135	22.31	202.92	1.68	1.03	0.53	212.14	1.02	217.29	4.000	No	No	2.00
136	22.47	215.45	1.61	0.87	0.51	223.48	1.00	223.48	4.000	No	No	2.00
137	22.64	215.01	1.59	0.81	0.50	221.97	1.00	221.97	4.000	No	No	2.00
138	22.80	195.03	1.65	0.90	0.52	201.47	1.01	202.58	4.000	No	No	2.00
139	22.97	166.26	1.78	1.15	0.57	172.44	1.09	188.22	0.700	No	No	0.45
140	23.13	149.20	1.86	1.33	0.60	154.85	1.15	178.11	0.605	No	No	0.39
141	23.30	140.76	1.90	1.46	0.62	145.90	1.19	173.87	0.569	No	No	0.36
142	23.46	126.19	1.97	1.63	0.64	130.70	1.26	165.16	0.499	No	No	0.32
143	23.62	103.55	2.09	1.96	0.69	107.32	1.43	153.77	0.418	No	No	0.27
144	23.79	89.89	2.18	2.26	0.72	93.03	1.61	149.70	0.392	No	No	0.25

:: Cyclic Resistance Ratio (CRR) calculation data :: (continued)												
Point ID	Depth (ft)	q_t (tsf)	I_c	Fr (%)	n	Q_{tn}	K_c	$Q_{tn,cs}$	CRR _{7.5}	Belongs to trans. layer	Clay-like behaviour	FS
145	23.95	103.36	2.08	1.90	0.69	106.21	1.42	150.93	0.400	No	No	0.26
146	24.12	132.86	1.89	1.29	0.61	135.06	1.18	159.19	0.455	No	No	0.29
147	24.28	162.46	1.72	0.89	0.55	163.51	1.05	171.54	0.549	No	No	0.35
148	24.44	182.46	1.62	0.72	0.51	182.42	1.00	182.42	0.645	No	No	0.41
149	24.61	197.10	1.59	0.72	0.50	196.37	1.00	196.37	0.784	No	No	0.50
150	24.77	210.77	1.57	0.72	0.49	209.34	1.00	209.34	4.000	No	No	2.00
151	24.94	228.87	1.55	0.72	0.49	226.56	1.00	226.56	4.000	No	No	2.00
152	25.10	252.86	1.52	0.73	0.48	249.55	1.00	249.55	4.000	No	No	2.00
153	25.26	280.02	1.50	0.75	0.47	275.58	1.00	275.58	4.000	No	No	2.00
154	25.43	306.41	1.49	0.79	0.46	300.73	1.00	300.73	4.000	No	No	2.00
155	25.59	329.48	1.48	0.81	0.46	322.52	1.00	322.52	4.000	No	No	2.00
156	25.76	349.64	1.47	0.81	0.46	341.23	1.00	341.23	4.000	No	No	2.00
157	25.92	363.21	1.46	0.81	0.45	353.49	1.00	353.49	4.000	No	No	2.00
158	26.08	368.54	1.45	0.81	0.45	357.74	1.00	357.74	4.000	No	No	2.00
159	26.25	363.71	1.47	0.84	0.46	352.20	1.00	352.20	4.000	No	No	2.00
160	26.41	348.04	1.51	0.92	0.47	336.41	1.00	336.41	4.000	No	No	2.00
161	26.58	328.04	1.58	1.06	0.50	316.47	1.00	316.47	4.000	No	No	2.00
162	26.74	312.07	1.64	1.20	0.52	300.43	1.00	300.43	4.000	No	No	2.00
163	26.90	303.44	1.64	1.19	0.52	291.23	1.00	290.32	4.000	No	No	2.00
164	27.07	299.23	1.59	1.02	0.51	286.11	1.00	286.11	4.000	No	No	2.00
165	27.23	289.50	1.55	0.86	0.49	275.86	1.00	275.86	4.000	No	No	2.00
166	27.40	260.90	1.62	0.98	0.52	247.91	1.00	247.91	4.000	No	No	2.00
167	27.56	201.76	1.85	1.58	0.60	191.12	1.15	219.08	4.000	Yes	No	2.00
168	27.72	130.46	2.14	2.56	0.71	122.76	1.52	186.94	4.000	Yes	No	2.00
169	27.89	77.57	2.44	4.05	0.83	72.08	2.47	177.90	4.000	Yes	No	2.00
170	28.05	59.11	2.53	4.13	0.86	54.31	3.33	180.98	4.000	Yes	No	2.00
171	28.22	91.24	2.17	2.05	0.73	84.39	1.61	135.60	4.000	Yes	No	2.00
172	28.38	122.46	1.88	1.05	0.62	113.53	1.17	133.11	4.000	Yes	No	2.00
173	28.54	131.27	1.73	0.64	0.56	121.57	1.05	128.25	4.000	Yes	No	2.00
174	28.71	93.79	1.86	0.69	0.61	86.08	1.16	99.60	4.000	Yes	No	2.00
175	28.87	53.37	2.10	0.78	0.70	48.04	1.46	70.31	4.000	Yes	No	2.00
176	29.04	30.49	2.34	0.81	0.79	26.58	2.07	55.13	4.000	Yes	No	2.00
177	29.20	20.84	2.47	0.70	0.84	17.56	2.61	45.84	4.000	Yes	No	2.00
178	29.36	18.15	2.56	0.82	0.88	15.02	4.12	61.79	4.000	Yes	No	2.00
179	29.53	18.26	2.67	1.42	0.92	15.04	8.58	129.01	4.000	Yes	No	2.00
180	29.69	20.20	2.77	2.55	0.96	16.73	4.56	76.30	4.000	Yes	Yes	2.00
181	29.86	27.47	2.71	3.13	0.94	23.28	4.10	95.38	4.000	Yes	Yes	2.00
182	30.02	56.63	2.31	1.83	0.78	49.96	1.98	98.88	4.000	Yes	No	2.00
183	30.19	85.91	2.09	1.39	0.70	76.71	1.44	110.27	4.000	Yes	No	2.00
184	30.35	101.30	2.03	1.38	0.68	90.58	1.35	121.91	4.000	Yes	No	2.00
185	30.51	94.96	2.12	1.72	0.71	84.37	1.50	126.17	0.267	No	No	0.17
186	30.68	98.61	2.12	1.79	0.71	87.36	1.50	130.91	0.289	No	No	0.18
187	30.84	101.17	2.08	1.58	0.70	89.49	1.42	126.69	0.269	No	No	0.17
188	31.01	92.16	2.10	1.51	0.70	81.05	1.45	117.52	0.231	No	No	0.15
189	31.17	64.46	2.27	1.81	0.77	55.71	1.86	103.60	0.183	No	No	0.12
190	31.33	53.87	2.38	2.12	0.81	45.97	2.23	102.38	0.180	No	No	0.11
191	31.50	48.25	2.47	2.52	0.84	40.72	2.61	106.31	0.192	No	No	0.12
192	31.66	66.19	2.30	2.02	0.78	56.62	1.94	109.87	0.203	No	No	0.13

:: Cyclic Resistance Ratio (CRR) calculation data :: (continued)												
Point ID	Depth (ft)	q_t (tsf)	I_c	Fr (%)	n	Q_{tn}	K_c	$Q_{tn,cs}$	CRR _{7.5}	Belongs to trans. layer	Clay-like behaviour	FS
193	31.83	80.92	2.22	1.94	0.75	69.55	1.72	119.29	0.238	No	No	0.15
194	31.99	97.45	2.22	2.34	0.75	83.83	1.71	143.42	0.354	No	No	0.22
195	32.15	110.98	2.23	2.78	0.76	95.31	1.76	167.36	0.516	No	No	0.33
196	32.32	106.32	2.28	3.04	0.77	90.72	1.88	170.31	0.539	No	No	0.34
197	32.48	94.32	2.29	2.82	0.78	79.95	1.92	153.30	0.415	No	No	0.26
198	32.65	63.28	2.43	2.94	0.83	52.54	2.44	128.44	0.277	No	No	0.18
199	32.81	49.32	2.56	3.46	0.88	40.17	4.29	172.18	4.000	Yes	No	2.00
200	32.97	56.36	2.51	3.32	0.86	46.09	2.97	136.77	4.000	Yes	No	2.00
201	33.14	84.29	2.28	2.43	0.78	70.30	1.90	133.32	4.000	Yes	No	2.00
202	33.30	126.89	2.01	1.55	0.67	107.82	1.32	142.11	4.000	Yes	No	2.00
203	33.47	166.55	1.80	1.03	0.59	143.21	1.11	158.79	4.000	Yes	No	2.00
204	33.63	186.21	1.68	0.78	0.55	160.97	1.03	165.15	0.499	No	No	0.32
205	33.79	177.67	1.68	0.74	0.55	153.12	1.03	157.33	0.442	No	No	0.28
206	33.96	147.79	1.77	0.80	0.58	126.13	1.09	137.00	4.000	Yes	No	2.00
207	34.12	107.02	1.97	1.08	0.66	89.56	1.26	112.95	4.000	Yes	No	2.00
208	34.29	67.36	2.30	1.94	0.78	54.44	1.94	105.79	4.000	Yes	No	2.00
209	34.45	38.21	2.75	4.62	0.96	29.17	4.39	128.08	4.000	Yes	Yes	2.00
210	34.61	63.93	2.53	3.89	0.87	50.49	3.40	171.74	4.000	Yes	No	2.00
211	34.78	118.36	2.18	2.35	0.74	96.79	1.61	155.88	4.000	Yes	No	2.00
212	34.94	187.26	1.92	1.66	0.64	156.29	1.21	189.40	4.000	Yes	No	2.00
213	35.11	224.41	1.84	1.50	0.61	188.18	1.14	213.67	4.000	Yes	No	2.00
214	35.27	252.82	1.83	1.60	0.61	211.82	1.13	238.51	4.000	No	No	2.00
215	35.43	280.57	1.79	1.58	0.59	235.13	1.10	259.28	4.000	No	No	2.00
216	35.60	309.38	1.74	1.44	0.57	259.81	1.06	276.09	4.000	No	No	2.00
217	35.76	332.71	1.68	1.29	0.55	280.02	1.02	286.54	4.000	No	No	2.00
218	35.93	347.85	1.64	1.21	0.54	292.86	1.00	292.40	4.000	No	No	2.00
219	36.09	358.41	1.63	1.19	0.53	301.35	1.00	301.35	4.000	No	No	2.00
220	36.26	365.67	1.63	1.20	0.53	306.71	1.00	306.71	4.000	No	No	2.00
221	36.42	374.60	1.63	1.24	0.53	313.36	1.00	313.36	4.000	No	No	2.00
222	36.58	382.96	1.64	1.28	0.54	319.41	1.00	318.39	4.000	No	No	2.00
223	36.75	392.12	1.65	1.32	0.54	326.08	1.00	326.26	4.000	No	No	2.00
224	36.91	402.25	1.64	1.31	0.54	333.98	1.00	333.98	4.000	No	No	2.00
225	37.08	408.59	1.63	1.28	0.53	338.71	1.00	338.71	4.000	No	No	2.00
226	37.24	412.82	1.62	1.25	0.53	341.72	1.00	341.72	4.000	No	No	2.00
227	37.40	415.92	1.60	1.18	0.52	344.13	1.00	344.13	4.000	No	No	2.00
228	37.57	422.88	1.58	1.16	0.52	349.45	1.00	349.45	4.000	No	No	2.00
229	37.73	432.18	1.58	1.16	0.52	356.45	1.00	356.45	4.000	No	No	2.00
230	37.90	440.07	1.60	1.25	0.52	361.30	1.00	361.30	4.000	No	No	2.00
231	38.06	451.35	1.61	1.30	0.53	369.40	1.00	369.40	4.000	No	No	2.00
232	38.22	461.79	1.61	1.32	0.53	377.06	1.00	377.06	4.000	No	No	2.00
233	38.39	470.09	1.60	1.30	0.53	383.22	1.00	383.22	4.000	No	No	2.00
234	38.55	473.28	1.59	1.27	0.52	385.32	1.00	385.32	4.000	No	No	2.00
235	38.72	474.64	1.58	1.24	0.52	385.95	1.00	385.95	4.000	No	No	2.00
236	38.88	476.97	1.57	1.19	0.51	387.60	1.00	387.60	4.000	No	No	2.00
237	39.04	472.83	1.56	1.16	0.51	383.55	1.00	383.55	4.000	No	No	2.00
238	39.21	459.76	1.54	1.06	0.50	373.01	1.00	373.01	4.000	No	No	2.00
239	39.37	442.89	1.53	1.02	0.50	358.63	1.00	358.63	4.000	No	No	2.00
240	39.54	431.39	1.52	0.97	0.50	348.87	1.00	348.87	4.000	No	No	2.00

:: Cyclic Resistance Ratio (CRR) calculation data :: (continued)												
Point ID	Depth (ft)	q_t (tsf)	I_c	Fr (%)	n	Q_{tn}	K_c	$Q_{tn,cs}$	CRR _{7.5}	Belongs to trans. layer	Clay-like behaviour	FS
241	39.70	424.63	1.54	1.01	0.51	341.88	1.00	341.88	4.000	No	No	2.00
242	39.86	421.34	1.54	1.00	0.51	338.48	1.00	338.48	4.000	No	No	2.00
243	40.03	409.01	1.55	0.99	0.51	327.57	1.00	327.57	4.000	No	No	2.00
244	40.19	387.10	1.56	0.99	0.51	308.70	1.00	308.70	4.000	No	No	2.00
245	40.36	355.08	1.57	0.96	0.52	281.89	1.00	281.89	4.000	No	No	2.00
246	40.52	322.48	1.61	0.96	0.53	254.31	1.00	254.31	4.000	No	No	2.00
247	40.68	280.21	1.67	1.02	0.56	218.47	1.02	222.24	4.000	No	No	2.00
248	40.85	221.81	1.83	1.34	0.62	168.58	1.13	190.71	4.000	Yes	No	2.00
249	41.01	149.01	2.09	1.98	0.72	108.71	1.43	155.68	4.000	Yes	No	2.00
250	41.18	97.38	2.34	2.85	0.81	67.87	2.09	142.11	4.000	Yes	No	2.00
251	41.34	64.36	2.54	3.46	0.89	42.94	3.73	160.32	4.000	Yes	No	2.00
252	41.50	52.84	2.55	2.86	0.89	34.77	4.04	140.34	0.337	No	No	0.23
253	41.67	41.28	2.59	2.33	0.91	26.55	5.05	134.17	0.305	No	No	0.21
254	41.83	36.52	2.59	1.97	0.91	23.21	5.15	119.60	0.239	No	No	0.16
255	42.00	31.46	2.70	2.32	0.95	19.40	9.99	193.78	0.757	No	No	0.51
256	42.16	27.40	2.80	2.70	0.99	16.39	4.74	77.72	0.782	No	Yes	0.53
257	42.32	24.14	2.88	3.11	1.00	14.11	5.54	78.21	0.673	No	Yes	0.46
258	42.49	24.20	2.90	3.25	1.00	14.11	5.66	79.83	0.673	No	Yes	0.46
259	42.65	25.76	2.89	3.47	1.00	15.08	5.60	84.41	0.719	No	Yes	0.49
260	42.82	27.07	2.88	3.56	1.00	15.88	5.49	87.22	0.758	No	Yes	0.52
261	42.98	27.47	2.88	3.64	1.00	16.09	5.51	88.57	0.767	No	Yes	0.52
262	43.15	26.89	2.89	3.59	1.00	15.66	5.56	87.05	0.747	No	Yes	0.51
263	43.31	26.44	2.90	3.66	1.00	15.32	5.68	87.03	0.731	No	Yes	0.50
264	43.47	26.24	2.89	3.55	1.00	15.14	5.64	85.41	0.722	No	Yes	0.49
265	43.64	26.79	2.88	3.47	1.00	15.44	5.52	85.21	0.736	No	Yes	0.51
266	43.80	26.89	2.85	3.04	1.00	15.46	5.19	80.27	0.737	No	Yes	0.51
267	43.97	26.70	2.83	2.79	1.00	15.28	5.03	76.84	0.729	No	Yes	0.50
268	44.13	25.96	2.83	2.73	1.00	14.77	5.09	75.17	0.705	No	Yes	0.49
269	44.29	26.03	2.86	3.01	1.00	14.76	5.32	78.53	0.704	No	Yes	0.49
270	44.46	26.37	2.89	3.40	1.00	14.93	5.58	83.25	0.712	No	Yes	0.49
271	44.62	26.70	2.90	3.63	1.00	15.09	5.71	86.19	0.720	No	Yes	0.50
272	44.79	26.87	2.90	3.61	1.00	15.15	5.68	86.06	0.723	No	Yes	0.50
273	44.95	26.79	2.87	3.20	1.00	15.05	5.40	81.31	0.718	No	Yes	0.50
274	45.11	26.23	2.85	2.85	1.00	14.65	5.21	76.38	0.699	No	Yes	0.49
275	45.28	25.20	2.89	3.13	1.00	13.96	5.60	78.17	0.666	No	Yes	0.46
276	45.44	27.49	2.93	4.20	1.00	15.35	6.05	92.80	4.000	Yes	Yes	2.00
277	45.61	48.21	2.68	3.60	0.95	28.78	9.18	264.14	4.000	Yes	No	2.00
278	45.77	102.45	2.28	2.31	0.80	67.21	1.89	127.10	4.000	Yes	No	2.00
279	45.93	180.51	1.96	1.50	0.67	126.07	1.25	157.14	4.000	Yes	No	2.00
280	46.10	247.25	1.77	1.16	0.60	178.33	1.09	193.62	4.000	Yes	No	2.00
281	46.26	274.77	1.74	1.18	0.59	198.87	1.07	212.18	4.000	No	No	2.00
282	46.43	266.17	1.83	1.47	0.62	189.39	1.13	213.74	4.000	No	No	2.00
283	46.59	258.74	1.91	1.81	0.66	181.09	1.20	217.28	4.000	No	No	2.00
284	46.75	281.98	1.88	1.79	0.65	197.99	1.17	232.37	4.000	No	No	2.00
285	46.92	352.57	1.74	1.41	0.59	253.76	1.06	269.40	4.000	No	No	2.00
286	47.08	436.24	1.58	1.08	0.53	322.34	1.00	322.34	4.000	No	No	2.00
287	47.25	497.24	1.45	0.84	0.48	374.93	1.00	374.93	4.000	No	No	2.00
288	47.41	513.87	1.41	0.76	0.47	390.05	1.00	390.05	4.000	No	No	2.00

:: Cyclic Resistance Ratio (CRR) calculation data :: (continued)

Point ID	Depth (ft)	q_t (tsf)	I_c	Fr (%)	n	Q_{tn}	K_c	$Q_{tn,cs}$	CRR _{7.5}	Belongs to trans. layer	Clay-like behaviour	FS
289	47.57	498.20	1.41	0.74	0.47	377.30	1.00	377.30	4.000	No	No	2.00
290	47.74	451.53	1.49	0.87	0.50	335.94	1.00	335.94	4.000	No	No	2.00
291	47.90	423.46	1.59	1.08	0.54	308.99	1.00	308.99	4.000	No	No	2.00
292	48.07	403.92	1.68	1.35	0.57	289.03	1.03	297.02	4.000	No	No	2.00
293	48.23	425.28	1.69	1.43	0.58	303.31	1.03	313.40	4.000	No	No	2.00
294	48.39	438.61	1.67	1.37	0.57	313.54	1.02	318.97	4.000	No	No	2.00
295	48.56	441.71	1.63	1.24	0.55	317.28	1.00	317.28	4.000	No	No	2.00
296	48.72	414.77	1.65	1.23	0.56	296.33	1.00	296.70	4.000	No	No	2.00
297	48.89	353.44	1.72	1.32	0.59	248.26	1.05	260.85	4.000	No	No	2.00
298	49.05	293.51	1.81	1.47	0.62	201.81	1.12	225.04	4.000	No	No	2.00
299	49.22	281.59	1.80	1.35	0.62	193.64	1.10	213.72	4.000	No	No	2.00
300	49.38	299.67	1.74	1.23	0.60	207.84	1.07	221.78	4.000	No	No	2.00

Abbreviations

Depth:	Depth from free surface, at which CPT was performed (ft)
q_t :	Total cone resistance
I_c :	Soil behavior type index
Fr:	Normalized friction ratio (%)
n:	Stress exponent
Q_{tn} :	Normalized cone resistance
K_c :	Cone resistance correction factor due to fines
$Q_{tn,cs}$:	Normalized and adjusted cone resistance
CRR _{7.5} :	Cyclic resistance ratio for $M_w=7.5$
FS:	Factor of safety against soil liquefaction

:: Liquefaction Potential Index calculation data ::											
Depth (ft)	FS	F _L	w _z	d _z	LPI	Depth (ft)	FS	F _L	w _z	d _z	LPI
0.33	2.00	0.00	9.95	0.16	0.00	0.49	2.00	0.00	9.93	0.16	0.00
0.66	2.00	0.00	9.90	0.17	0.00	0.82	2.00	0.00	9.88	0.16	0.00
0.98	2.00	0.00	9.85	0.16	0.00	1.15	2.00	0.00	9.82	0.17	0.00
1.31	2.00	0.00	9.80	0.16	0.00	1.48	2.00	0.00	9.77	0.17	0.00
1.64	2.00	0.00	9.75	0.16	0.00	1.80	2.00	0.00	9.73	0.16	0.00
1.97	2.00	0.00	9.70	0.17	0.00	2.13	2.00	0.00	9.68	0.16	0.00
2.30	2.00	0.00	9.65	0.17	0.00	2.46	2.00	0.00	9.63	0.16	0.00
2.62	2.00	0.00	9.60	0.16	0.00	2.79	2.00	0.00	9.57	0.17	0.00
2.95	2.00	0.00	9.55	0.16	0.00	3.12	2.00	0.00	9.52	0.17	0.00
3.28	2.00	0.00	9.50	0.16	0.00	3.45	2.00	0.00	9.47	0.17	0.00
3.61	2.00	0.00	9.45	0.16	0.00	3.77	2.00	0.00	9.43	0.16	0.00
3.94	2.00	0.00	9.40	0.17	0.00	4.10	2.00	0.00	9.38	0.16	0.00
4.27	2.00	0.00	9.35	0.17	0.00	4.43	2.00	0.00	9.32	0.16	0.00
4.59	2.00	0.00	9.30	0.16	0.00	4.76	2.00	0.00	9.27	0.17	0.00
4.92	2.00	0.00	9.25	0.16	0.00	5.09	0.69	0.31	9.22	0.17	0.15
5.25	0.62	0.38	9.20	0.16	0.17	5.41	0.57	0.43	9.18	0.16	0.19
5.58	0.53	0.47	9.15	0.17	0.22	5.74	0.52	0.48	9.13	0.16	0.21
5.91	0.54	0.46	9.10	0.17	0.22	6.07	0.59	0.41	9.07	0.16	0.18
6.23	0.65	0.35	9.05	0.16	0.16	6.40	0.70	0.30	9.02	0.17	0.14
6.56	2.00	0.00	9.00	0.16	0.00	6.73	2.00	0.00	8.97	0.17	0.00
6.89	2.00	0.00	8.95	0.16	0.00	7.05	2.00	0.00	8.93	0.16	0.00
7.22	2.00	0.00	8.90	0.17	0.00	7.38	2.00	0.00	8.88	0.16	0.00
7.55	2.00	0.00	8.85	0.17	0.00	7.71	2.00	0.00	8.82	0.16	0.00
7.87	2.00	0.00	8.80	0.16	0.00	8.04	2.00	0.00	8.77	0.17	0.00
8.20	2.00	0.00	8.75	0.16	0.00	8.37	2.00	0.00	8.72	0.17	0.00
8.53	2.00	0.00	8.70	0.16	0.00	8.69	2.00	0.00	8.68	0.16	0.00
8.86	2.00	0.00	8.65	0.17	0.00	9.02	2.00	0.00	8.63	0.16	0.00
9.19	2.00	0.00	8.60	0.17	0.00	9.35	2.00	0.00	8.58	0.16	0.00
9.51	2.00	0.00	8.55	0.16	0.00	9.68	2.00	0.00	8.52	0.17	0.00
9.84	0.52	0.48	8.50	0.16	0.20	10.01	0.35	0.65	8.47	0.17	0.28
10.17	0.29	0.71	8.45	0.16	0.29	10.34	0.29	0.71	8.42	0.17	0.31
10.50	0.33	0.67	8.40	0.16	0.28	10.66	0.38	0.62	8.38	0.16	0.25
10.83	0.46	0.54	8.35	0.17	0.24	10.99	0.59	0.41	8.33	0.16	0.17
11.16	2.00	0.00	8.30	0.17	0.00	11.32	2.00	0.00	8.27	0.16	0.00
11.48	2.00	0.00	8.25	0.16	0.00	11.65	2.00	0.00	8.22	0.17	0.00
11.81	2.00	0.00	8.20	0.16	0.00	11.98	2.00	0.00	8.17	0.17	0.00
12.14	2.00	0.00	8.15	0.16	0.00	12.30	2.00	0.00	8.13	0.16	0.00
12.47	2.00	0.00	8.10	0.17	0.00	12.63	2.00	0.00	8.08	0.16	0.00
12.80	2.00	0.00	8.05	0.17	0.00	12.96	2.00	0.00	8.02	0.16	0.00
13.12	2.00	0.00	8.00	0.16	0.00	13.29	2.00	0.00	7.97	0.17	0.00
13.45	2.00	0.00	7.95	0.16	0.00	13.62	2.00	0.00	7.92	0.17	0.00
13.78	2.00	0.00	7.90	0.16	0.00	13.94	2.00	0.00	7.88	0.16	0.00
14.11	2.00	0.00	7.85	0.17	0.00	14.27	2.00	0.00	7.83	0.16	0.00
14.44	2.00	0.00	7.80	0.17	0.00	14.60	2.00	0.00	7.77	0.16	0.00
14.76	2.00	0.00	7.75	0.16	0.00	14.93	2.00	0.00	7.72	0.17	0.00
15.09	2.00	0.00	7.70	0.16	0.00	15.26	2.00	0.00	7.67	0.17	0.00
15.42	2.00	0.00	7.65	0.16	0.00	15.58	2.00	0.00	7.63	0.16	0.00
15.75	2.00	0.00	7.60	0.17	0.00	15.91	2.00	0.00	7.58	0.16	0.00

:: Liquefaction Potential Index calculation data :: (continued)											
Depth (ft)	FS	F _L	w _z	d _z	LPI	Depth (ft)	FS	F _L	w _z	d _z	LPI
16.08	2.00	0.00	7.55	0.17	0.00	16.24	2.00	0.00	7.53	0.16	0.00
16.40	2.00	0.00	7.50	0.16	0.00	16.57	2.00	0.00	7.47	0.17	0.00
16.73	2.00	0.00	7.45	0.16	0.00	16.90	2.00	0.00	7.42	0.17	0.00
17.06	2.00	0.00	7.40	0.16	0.00	17.23	2.00	0.00	7.37	0.17	0.00
17.39	2.00	0.00	7.35	0.16	0.00	17.55	2.00	0.00	7.33	0.16	0.00
17.72	2.00	0.00	7.30	0.17	0.00	17.88	2.00	0.00	7.28	0.16	0.00
18.05	2.00	0.00	7.25	0.17	0.00	18.21	2.00	0.00	7.22	0.16	0.00
18.37	2.00	0.00	7.20	0.16	0.00	18.54	0.53	0.47	7.17	0.17	0.18
18.70	0.29	0.71	7.15	0.16	0.25	18.87	0.20	0.80	7.12	0.17	0.30
19.03	0.13	0.87	7.10	0.16	0.30	19.19	0.13	0.87	7.08	0.16	0.30
19.36	0.25	0.75	7.05	0.17	0.28	19.52	0.50	0.50	7.03	0.16	0.17
19.69	2.00	0.00	7.00	0.17	0.00	19.85	2.00	0.00	6.97	0.16	0.00
20.01	2.00	0.00	6.95	0.16	0.00	20.18	2.00	0.00	6.92	0.17	0.00
20.34	0.42	0.58	6.90	0.16	0.19	20.51	0.25	0.75	6.87	0.17	0.27
20.67	0.15	0.85	6.85	0.16	0.28	20.83	0.15	0.85	6.83	0.16	0.28
21.00	0.18	0.82	6.80	0.17	0.29	21.16	0.33	0.67	6.78	0.16	0.22
21.33	0.48	0.52	6.75	0.17	0.18	21.49	0.51	0.49	6.72	0.16	0.16
21.65	0.48	0.52	6.70	0.16	0.17	21.82	0.47	0.53	6.67	0.17	0.18
21.98	0.51	0.49	6.65	0.16	0.16	22.15	2.00	0.00	6.62	0.17	0.00
22.31	2.00	0.00	6.60	0.16	0.00	22.47	2.00	0.00	6.58	0.16	0.00
22.64	2.00	0.00	6.55	0.17	0.00	22.80	2.00	0.00	6.53	0.16	0.00
22.97	0.45	0.55	6.50	0.17	0.19	23.13	0.39	0.61	6.47	0.16	0.19
23.30	0.36	0.64	6.45	0.17	0.21	23.46	0.32	0.68	6.42	0.16	0.21
23.62	0.27	0.73	6.40	0.16	0.23	23.79	0.25	0.75	6.37	0.17	0.25
23.95	0.26	0.74	6.35	0.16	0.23	24.12	0.29	0.71	6.32	0.17	0.23
24.28	0.35	0.65	6.30	0.16	0.20	24.44	0.41	0.59	6.28	0.16	0.18
24.61	0.50	0.50	6.25	0.17	0.16	24.77	2.00	0.00	6.23	0.16	0.00
24.94	2.00	0.00	6.20	0.17	0.00	25.10	2.00	0.00	6.17	0.16	0.00
25.26	2.00	0.00	6.15	0.16	0.00	25.43	2.00	0.00	6.12	0.17	0.00
25.59	2.00	0.00	6.10	0.16	0.00	25.76	2.00	0.00	6.07	0.17	0.00
25.92	2.00	0.00	6.05	0.16	0.00	26.08	2.00	0.00	6.03	0.16	0.00
26.25	2.00	0.00	6.00	0.17	0.00	26.41	2.00	0.00	5.98	0.16	0.00
26.58	2.00	0.00	5.95	0.17	0.00	26.74	2.00	0.00	5.92	0.16	0.00
26.90	2.00	0.00	5.90	0.16	0.00	27.07	2.00	0.00	5.87	0.17	0.00
27.23	2.00	0.00	5.85	0.16	0.00	27.40	2.00	0.00	5.82	0.17	0.00
27.56	2.00	0.00	5.80	0.16	0.00	27.72	2.00	0.00	5.78	0.16	0.00
27.89	2.00	0.00	5.75	0.17	0.00	28.05	2.00	0.00	5.73	0.16	0.00
28.22	2.00	0.00	5.70	0.17	0.00	28.38	2.00	0.00	5.67	0.16	0.00
28.54	2.00	0.00	5.65	0.16	0.00	28.71	2.00	0.00	5.62	0.17	0.00
28.87	2.00	0.00	5.60	0.16	0.00	29.04	2.00	0.00	5.57	0.17	0.00
29.20	2.00	0.00	5.55	0.16	0.00	29.36	2.00	0.00	5.53	0.16	0.00
29.53	2.00	0.00	5.50	0.17	0.00	29.69	2.00	0.00	5.48	0.16	0.00
29.86	2.00	0.00	5.45	0.17	0.00	30.02	2.00	0.00	5.42	0.16	0.00
30.19	2.00	0.00	5.40	0.17	0.00	30.35	2.00	0.00	5.37	0.16	0.00
30.51	0.17	0.83	5.35	0.16	0.22	30.68	0.18	0.82	5.32	0.17	0.23
30.84	0.17	0.83	5.30	0.16	0.21	31.01	0.15	0.85	5.27	0.17	0.23
31.17	0.12	0.88	5.25	0.16	0.23	31.33	0.11	0.89	5.23	0.16	0.23
31.50	0.12	0.88	5.20	0.17	0.24	31.66	0.13	0.87	5.18	0.16	0.22

:: Liquefaction Potential Index calculation data :: (continued)											
Depth (ft)	FS	F _L	w _z	d _z	LPI	Depth (ft)	FS	F _L	w _z	d _z	LPI
31.83	0.15	0.85	5.15	0.17	0.23	31.99	0.22	0.78	5.12	0.16	0.19
32.15	0.33	0.67	5.10	0.16	0.17	32.32	0.34	0.66	5.07	0.17	0.17
32.48	0.26	0.74	5.05	0.16	0.18	32.65	0.18	0.82	5.02	0.17	0.21
32.81	2.00	0.00	5.00	0.16	0.00	32.97	2.00	0.00	4.98	0.16	0.00
33.14	2.00	0.00	4.95	0.17	0.00	33.30	2.00	0.00	4.93	0.16	0.00
33.47	2.00	0.00	4.90	0.17	0.00	33.63	0.32	0.68	4.87	0.16	0.16
33.79	0.28	0.72	4.85	0.16	0.17	33.96	2.00	0.00	4.82	0.17	0.00
34.12	2.00	0.00	4.80	0.16	0.00	34.29	2.00	0.00	4.77	0.17	0.00
34.45	2.00	0.00	4.75	0.16	0.00	34.61	2.00	0.00	4.73	0.16	0.00
34.78	2.00	0.00	4.70	0.17	0.00	34.94	2.00	0.00	4.68	0.16	0.00
35.11	2.00	0.00	4.65	0.17	0.00	35.27	2.00	0.00	4.62	0.16	0.00
35.43	2.00	0.00	4.60	0.16	0.00	35.60	2.00	0.00	4.57	0.17	0.00
35.76	2.00	0.00	4.55	0.16	0.00	35.93	2.00	0.00	4.52	0.17	0.00
36.09	2.00	0.00	4.50	0.16	0.00	36.26	2.00	0.00	4.47	0.17	0.00
36.42	2.00	0.00	4.45	0.16	0.00	36.58	2.00	0.00	4.43	0.16	0.00
36.75	2.00	0.00	4.40	0.17	0.00	36.91	2.00	0.00	4.37	0.16	0.00
37.08	2.00	0.00	4.35	0.17	0.00	37.24	2.00	0.00	4.32	0.16	0.00
37.40	2.00	0.00	4.30	0.16	0.00	37.57	2.00	0.00	4.27	0.17	0.00
37.73	2.00	0.00	4.25	0.16	0.00	37.90	2.00	0.00	4.22	0.17	0.00
38.06	2.00	0.00	4.20	0.16	0.00	38.22	2.00	0.00	4.18	0.16	0.00
38.39	2.00	0.00	4.15	0.17	0.00	38.55	2.00	0.00	4.12	0.16	0.00
38.72	2.00	0.00	4.10	0.17	0.00	38.88	2.00	0.00	4.07	0.16	0.00
39.04	2.00	0.00	4.05	0.16	0.00	39.21	2.00	0.00	4.02	0.17	0.00
39.37	2.00	0.00	4.00	0.16	0.00	39.54	2.00	0.00	3.97	0.17	0.00
39.70	2.00	0.00	3.95	0.16	0.00	39.86	2.00	0.00	3.93	0.16	0.00
40.03	2.00	0.00	3.90	0.17	0.00	40.19	2.00	0.00	3.88	0.16	0.00
40.36	2.00	0.00	3.85	0.17	0.00	40.52	2.00	0.00	3.82	0.16	0.00
40.68	2.00	0.00	3.80	0.16	0.00	40.85	2.00	0.00	3.77	0.17	0.00
41.01	2.00	0.00	3.75	0.16	0.00	41.18	2.00	0.00	3.72	0.17	0.00
41.34	2.00	0.00	3.70	0.16	0.00	41.50	0.23	0.77	3.68	0.16	0.14
41.67	0.21	0.79	3.65	0.17	0.15	41.83	0.16	0.84	3.63	0.16	0.15
42.00	0.51	0.49	3.60	0.17	0.09	42.16	0.53	0.47	3.57	0.16	0.08
42.32	0.46	0.54	3.55	0.16	0.09	42.49	0.46	0.54	3.52	0.17	0.10
42.65	0.49	0.51	3.50	0.16	0.09	42.82	0.52	0.48	3.47	0.17	0.09
42.98	0.52	0.48	3.45	0.16	0.08	43.15	0.51	0.49	3.42	0.17	0.09
43.31	0.50	0.50	3.40	0.16	0.08	43.47	0.49	0.51	3.38	0.16	0.08
43.64	0.51	0.49	3.35	0.17	0.09	43.80	0.51	0.49	3.32	0.16	0.08
43.97	0.50	0.50	3.30	0.17	0.09	44.13	0.49	0.51	3.27	0.16	0.08
44.29	0.49	0.51	3.25	0.16	0.08	44.46	0.49	0.51	3.22	0.17	0.08
44.62	0.50	0.50	3.20	0.16	0.08	44.79	0.50	0.50	3.17	0.17	0.08
44.95	0.50	0.50	3.15	0.16	0.08	45.11	0.49	0.51	3.13	0.16	0.08
45.28	0.46	0.54	3.10	0.17	0.09	45.44	2.00	0.00	3.07	0.16	0.00
45.61	2.00	0.00	3.05	0.17	0.00	45.77	2.00	0.00	3.02	0.16	0.00
45.93	2.00	0.00	3.00	0.16	0.00	46.10	2.00	0.00	2.97	0.17	0.00
46.26	2.00	0.00	2.95	0.16	0.00	46.43	2.00	0.00	2.92	0.17	0.00
46.59	2.00	0.00	2.90	0.16	0.00	46.75	2.00	0.00	2.88	0.16	0.00
46.92	2.00	0.00	2.85	0.17	0.00	47.08	2.00	0.00	2.83	0.16	0.00
47.25	2.00	0.00	2.80	0.17	0.00	47.41	2.00	0.00	2.77	0.16	0.00

:: Liquefaction Potential Index calculation data :: (continued)

Depth (ft)	FS	F_L	w_z	d_z	LPI	Depth (ft)	FS	F_L	w_z	d_z	LPI
47.57	2.00	0.00	2.75	0.16	0.00	47.74	2.00	0.00	2.72	0.17	0.00
47.90	2.00	0.00	2.70	0.16	0.00	48.07	2.00	0.00	2.67	0.17	0.00
48.23	2.00	0.00	2.65	0.16	0.00	48.39	2.00	0.00	2.63	0.16	0.00
48.56	2.00	0.00	2.60	0.17	0.00	48.72	2.00	0.00	2.58	0.16	0.00
48.89	2.00	0.00	2.55	0.17	0.00	49.05	2.00	0.00	2.52	0.16	0.00
49.22	2.00	0.00	2.50	0.17	0.00	49.38	2.00	0.00	2.47	0.16	0.00

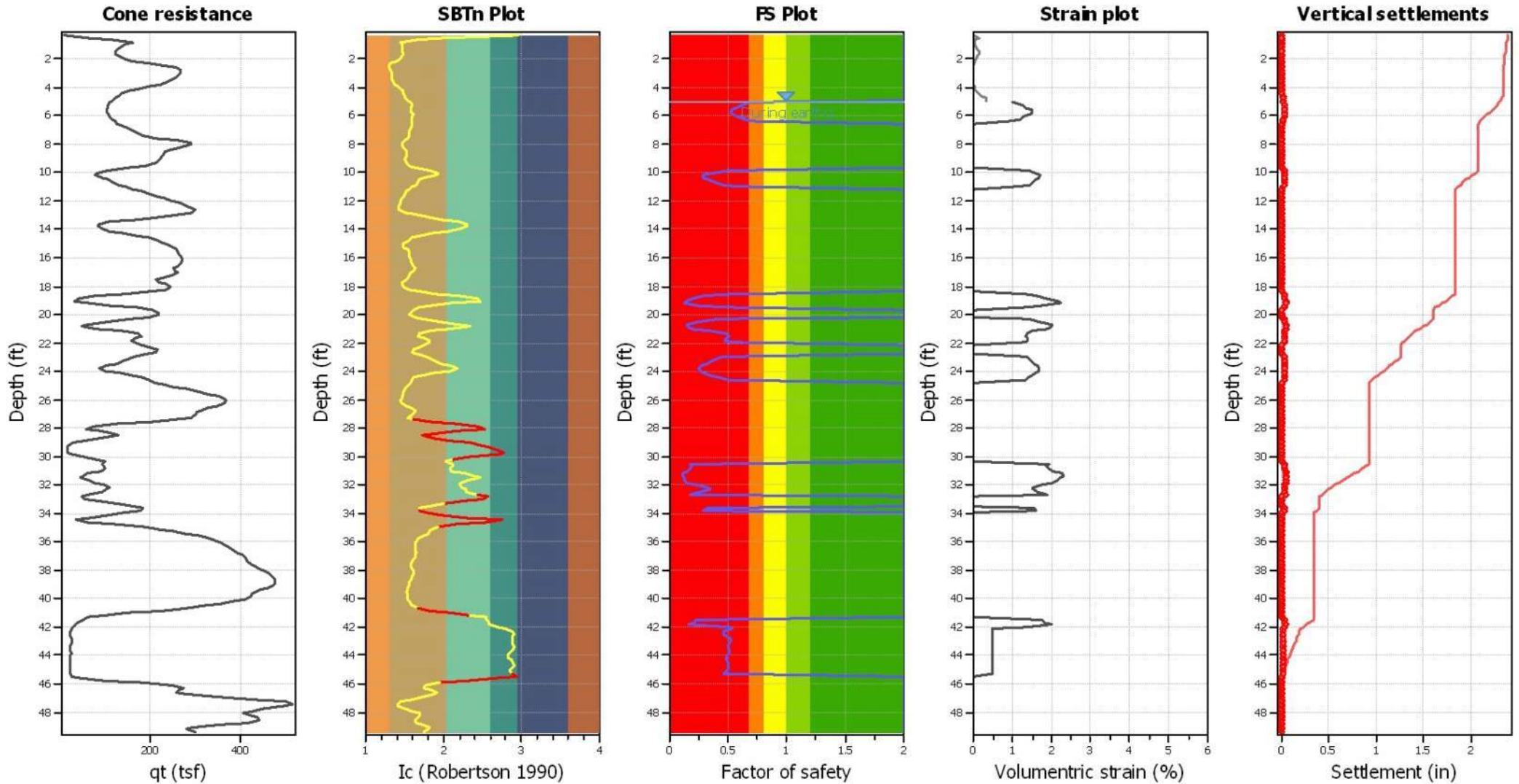
Overall liquefaction potential: 15.59

LPI = 0.00 - Liquefaction risk very low
 LPI between 0.00 and 5.00 - Liquefaction risk low
 LPI between 5.00 and 15.00 - Liquefaction risk high
 LPI > 15.00 - Liquefaction risk very high

Abbreviations

FS: Calculated factor of safety for test point
 F_L : 1 - FS
 w_z : Function value of the extend of soil liquefaction according to depth
 d_z : Layer thickness (ft)
 LPI: Liquefaction potential index value for test point

Estimation of post-earthquake settlements



Abbreviations

- qt: Total cone resistance (cone resistance q_c corrected for pore water effects)
- I_c : Soil Behaviour Type Index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post-liquefaction volumetric strain

:: Post-earthquake settlement of dry sands ::													
Depth (ft)	Ic	Kc	Qc1n	Qc1n,cs	N1,60 (blows)	Vs (ft/s)	Gmax (tsf)	CSR	Shear, γ (%)	Svol,15 (%)	Nc	ev (%)	Settle. (in)
0.33	2.95	6.23	23.59	146.95	0	0.0	0	1.01	0.000	0.00	0.00	0.00	0.000
0.49	1.95	1.24	129.17	160.25	33	887.2	244	1.01	0.256	0.14	21.37	0.17	0.006
0.66	1.66	1.01	219.31	222.20	41	964.1	342	1.01	0.092	0.04	21.37	0.05	0.002
0.82	1.45	1.00	304.68	304.68	52	994.2	409	1.01	0.070	0.02	21.37	0.03	0.001
0.98	1.47	1.00	275.75	275.75	48	959.0	413	1.01	0.104	0.04	21.37	0.04	0.002
1.15	1.46	1.00	258.60	258.60	45	919.2	406	1.00	0.173	0.07	21.37	0.08	0.003
1.31	1.46	1.00	243.65	243.65	42	891.6	404	1.00	0.256	0.11	21.37	0.12	0.005
1.48	1.46	1.00	236.20	236.20	41	881.0	417	1.00	0.300	0.13	21.37	0.15	0.006
1.64	1.48	1.00	236.38	236.38	41	888.6	448	1.00	0.269	0.11	21.37	0.13	0.005
1.80	1.47	1.00	247.02	247.02	43	907.5	493	1.00	0.209	0.08	21.37	0.10	0.004
1.97	1.45	1.00	268.68	268.68	46	930.0	545	1.00	0.160	0.06	21.37	0.07	0.003
2.13	1.38	1.00	308.88	308.88	52	958.1	607	1.00	0.118	0.04	21.37	0.04	0.002
2.30	1.32	1.00	370.12	370.12	61	1009.9	710	1.00	0.074	0.02	21.37	0.02	0.001
2.46	1.29	1.00	435.52	435.52	71	1073.8	845	1.00	0.046	0.01	21.37	0.01	0.000
2.62	1.30	1.00	476.00	476.00	78	1127.9	977	1.00	0.034	0.01	21.37	0.01	0.000
2.79	1.32	1.00	490.39	490.39	81	1157.9	1072	1.00	0.030	0.01	21.37	0.01	0.000
2.95	1.33	1.00	485.70	485.70	80	1163.0	1116	1.00	0.030	0.01	21.37	0.01	0.000
3.12	1.34	1.00	470.08	470.08	78	1150.4	1123	1.00	0.032	0.01	21.37	0.01	0.000
3.28	1.34	1.00	451.41	451.41	75	1127.0	1103	1.00	0.037	0.01	21.37	0.01	0.000
3.45	1.34	1.00	430.42	430.42	72	1102.3	1079	1.00	0.042	0.01	21.37	0.01	0.000
3.61	1.35	1.00	407.42	407.42	68	1078.8	1053	1.00	0.049	0.01	21.37	0.01	0.001
3.77	1.38	1.00	377.95	377.95	63	1054.7	1024	1.00	0.058	0.01	21.37	0.02	0.001
3.94	1.41	1.00	339.88	339.88	58	1023.1	978	1.00	0.074	0.02	21.37	0.02	0.001
4.10	1.45	1.00	300.51	300.51	52	983.6	913	1.00	0.102	0.03	21.37	0.04	0.001
4.27	1.48	1.00	264.68	264.68	46	941.8	845	1.00	0.153	0.06	21.37	0.07	0.003
4.43	1.49	1.00	233.66	233.66	41	890.0	756	1.00	0.274	0.12	21.37	0.14	0.005
4.59	1.50	1.00	215.67	215.67	38	860.3	713	1.00	0.407	0.19	21.37	0.22	0.009
4.76	1.50	1.00	203.54	203.54	36	838.7	684	1.00	0.557	0.28	21.37	0.33	0.013
4.92	1.54	1.00	195.35	195.35	35	842.9	704	1.00	0.522	0.27	21.37	0.32	0.012

Total estimated settlement: 0.09

:: Post-earthquake settlement due to soil liquefaction ::											
Depth (ft)	Q _{tn,cs}	FS	e _v (%)	DF	Settlement (in)	Depth (ft)	Q _{tn,cs}	FS	e _v (%)	DF	Settlement (in)
5.09	187.45	0.69	1.01	1.00	0.02	5.25	181.37	0.62	1.28	1.00	0.02
5.41	176.83	0.57	1.33	1.00	0.03	5.58	172.77	0.53	1.49	1.00	0.03
5.74	172.39	0.52	1.50	1.00	0.03	5.91	175.14	0.54	1.48	1.00	0.03
6.07	182.29	0.59	1.27	1.00	0.02	6.23	189.51	0.65	1.20	1.00	0.02
6.40	196.59	0.70	0.94	1.00	0.02	6.56	204.38	2.00	0.00	1.00	0.00
6.73	217.40	2.00	0.00	1.00	0.00	6.89	236.80	2.00	0.00	1.00	0.00
7.05	254.47	2.00	0.00	1.00	0.00	7.22	262.29	2.00	0.00	1.00	0.00
7.38	282.12	2.00	0.00	1.00	0.00	7.55	321.07	2.00	0.00	1.00	0.00
7.71	380.47	2.00	0.00	1.00	0.00	7.87	419.16	2.00	0.00	1.00	0.00
8.04	415.38	2.00	0.00	1.00	0.00	8.20	382.75	2.00	0.00	1.00	0.00
8.37	349.50	2.00	0.00	1.00	0.00	8.53	335.73	2.00	0.00	1.00	0.00
8.69	328.49	2.00	0.00	1.00	0.00	8.86	319.45	2.00	0.00	1.00	0.00
9.02	311.36	2.00	0.00	1.00	0.00	9.19	303.16	2.00	0.00	1.00	0.00

:: Post-earthquake settlement due to soil liquefaction :: (continued)											
Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)
9.35	291.46	2.00	0.00	1.00	0.00	9.51	262.70	2.00	0.00	1.00	0.00
9.68	219.30	2.00	0.00	1.00	0.00	9.84	186.09	0.52	1.40	1.00	0.03
10.01	160.45	0.35	1.59	1.00	0.03	10.17	147.37	0.29	1.70	1.00	0.03
10.34	148.85	0.29	1.69	1.00	0.03	10.50	156.78	0.33	1.62	1.00	0.03
10.66	167.20	0.38	1.53	1.00	0.03	10.83	179.28	0.46	1.45	1.00	0.03
10.99	197.73	0.59	1.13	1.00	0.02	11.16	218.24	2.00	0.00	1.00	0.00
11.32	238.57	2.00	0.00	1.00	0.00	11.48	260.08	2.00	0.00	1.00	0.00
11.65	279.38	2.00	0.00	1.00	0.00	11.81	298.59	2.00	0.00	1.00	0.00
11.98	315.53	2.00	0.00	1.00	0.00	12.14	333.18	2.00	0.00	1.00	0.00
12.30	349.91	2.00	0.00	1.00	0.00	12.47	364.62	2.00	0.00	1.00	0.00
12.63	371.46	2.00	0.00	1.00	0.00	12.80	371.41	2.00	0.00	1.00	0.00
12.96	351.80	2.00	0.00	1.00	0.00	13.12	333.80	2.00	0.00	1.00	0.00
13.29	296.96	2.00	0.00	1.00	0.00	13.45	269.76	2.00	0.00	1.00	0.00
13.62	260.05	2.00	0.00	1.00	0.00	13.78	247.56	2.00	0.00	1.00	0.00
13.94	226.73	2.00	0.00	1.00	0.00	14.11	209.49	2.00	0.00	1.00	0.00
14.27	208.66	2.00	0.00	1.00	0.00	14.44	221.56	2.00	0.00	1.00	0.00
14.60	243.12	2.00	0.00	1.00	0.00	14.76	261.27	2.00	0.00	1.00	0.00
14.93	272.33	2.00	0.00	1.00	0.00	15.09	285.15	2.00	0.00	1.00	0.00
15.26	298.94	2.00	0.00	1.00	0.00	15.42	308.46	2.00	0.00	1.00	0.00
15.58	313.39	2.00	0.00	1.00	0.00	15.75	315.06	2.00	0.00	1.00	0.00
15.91	317.63	2.00	0.00	1.00	0.00	16.08	318.75	2.00	0.00	1.00	0.00
16.24	320.07	2.00	0.00	1.00	0.00	16.40	316.30	2.00	0.00	1.00	0.00
16.57	305.97	2.00	0.00	1.00	0.00	16.73	296.78	2.00	0.00	1.00	0.00
16.90	298.50	2.00	0.00	1.00	0.00	17.06	301.12	2.00	0.00	1.00	0.00
17.23	285.75	2.00	0.00	1.00	0.00	17.39	256.29	2.00	0.00	1.00	0.00
17.55	240.32	2.00	0.00	1.00	0.00	17.72	245.58	2.00	0.00	1.00	0.00
17.88	262.51	2.00	0.00	1.00	0.00	18.05	273.02	2.00	0.00	1.00	0.00
18.21	265.76	2.00	0.00	1.00	0.00	18.37	236.64	2.00	0.00	1.00	0.00
18.54	197.35	0.53	1.34	1.00	0.03	18.70	158.01	0.29	1.61	1.00	0.03
18.87	133.32	0.20	1.85	1.00	0.04	19.03	108.74	0.13	2.18	1.00	0.04
19.19	106.26	0.13	2.22	1.00	0.04	19.36	146.98	0.25	1.70	1.00	0.03
19.52	194.14	0.50	1.36	1.00	0.03	19.69	227.12	2.00	0.00	1.00	0.00
19.85	239.86	2.00	0.00	1.00	0.00	20.01	236.88	2.00	0.00	1.00	0.00
20.18	214.03	2.00	0.00	1.00	0.00	20.34	183.17	0.42	1.42	1.00	0.03
20.51	149.13	0.25	1.68	1.00	0.03	20.67	119.15	0.15	2.02	1.00	0.04
20.83	118.98	0.15	2.03	1.00	0.04	21.00	129.22	0.18	1.89	1.00	0.04
21.16	165.94	0.33	1.54	1.00	0.03	21.33	192.20	0.48	1.37	1.00	0.03
21.49	197.31	0.51	1.34	1.00	0.03	21.65	192.83	0.48	1.36	1.00	0.03
21.82	191.65	0.47	1.37	1.00	0.03	21.98	196.63	0.51	1.34	1.00	0.03
22.15	206.45	2.00	0.00	1.00	0.00	22.31	217.29	2.00	0.00	1.00	0.00
22.47	223.48	2.00	0.00	1.00	0.00	22.64	221.97	2.00	0.00	1.00	0.00
22.80	202.58	2.00	0.00	1.00	0.00	22.97	188.22	0.45	1.39	1.00	0.03
23.13	178.11	0.39	1.46	1.00	0.03	23.30	173.87	0.36	1.48	1.00	0.03
23.46	165.16	0.32	1.55	1.00	0.03	23.62	153.77	0.27	1.64	1.00	0.03
23.79	149.70	0.25	1.68	1.00	0.03	23.95	150.93	0.26	1.67	1.00	0.03
24.12	159.19	0.29	1.60	1.00	0.03	24.28	171.54	0.35	1.50	1.00	0.03
24.44	182.42	0.41	1.43	1.00	0.03	24.61	196.37	0.50	1.34	1.00	0.03
24.77	209.34	2.00	0.00	1.00	0.00	24.94	226.56	2.00	0.00	1.00	0.00

:: Post-earthquake settlement due to soil liquefaction :: (continued)											
Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)
25.10	249.55	2.00	0.00	1.00	0.00	25.26	275.58	2.00	0.00	1.00	0.00
25.43	300.73	2.00	0.00	1.00	0.00	25.59	322.52	2.00	0.00	1.00	0.00
25.76	341.23	2.00	0.00	1.00	0.00	25.92	353.49	2.00	0.00	1.00	0.00
26.08	357.74	2.00	0.00	1.00	0.00	26.25	352.20	2.00	0.00	1.00	0.00
26.41	336.41	2.00	0.00	1.00	0.00	26.58	316.47	2.00	0.00	1.00	0.00
26.74	300.43	2.00	0.00	1.00	0.00	26.90	290.32	2.00	0.00	1.00	0.00
27.07	286.11	2.00	0.00	1.00	0.00	27.23	275.86	2.00	0.00	1.00	0.00
27.40	247.91	2.00	0.00	1.00	0.00	27.56	219.08	2.00	0.00	1.00	0.00
27.72	186.94	2.00	0.00	1.00	0.00	27.89	177.90	2.00	0.00	1.00	0.00
28.05	180.98	2.00	0.00	1.00	0.00	28.22	135.60	2.00	0.00	1.00	0.00
28.38	133.11	2.00	0.00	1.00	0.00	28.54	128.25	2.00	0.00	1.00	0.00
28.71	99.60	2.00	0.00	1.00	0.00	28.87	70.31	2.00	0.00	1.00	0.00
29.04	55.13	2.00	0.00	1.00	0.00	29.20	45.84	2.00	0.00	1.00	0.00
29.36	61.79	2.00	0.00	1.00	0.00	29.53	129.01	2.00	0.00	1.00	0.00
29.69	76.30	2.00	0.00	1.00	0.00	29.86	95.38	2.00	0.00	1.00	0.00
30.02	98.88	2.00	0.00	1.00	0.00	30.19	110.27	2.00	0.00	1.00	0.00
30.35	121.91	2.00	0.00	1.00	0.00	30.51	126.17	0.17	1.93	1.00	0.04
30.68	130.91	0.18	1.87	1.00	0.04	30.84	126.69	0.17	1.92	1.00	0.04
31.01	117.52	0.15	2.05	1.00	0.04	31.17	103.60	0.12	2.27	1.00	0.04
31.33	102.38	0.11	2.29	1.00	0.04	31.50	106.31	0.12	2.22	1.00	0.05
31.66	109.87	0.13	2.16	1.00	0.04	31.83	119.29	0.15	2.02	1.00	0.04
31.99	143.42	0.22	1.74	1.00	0.03	32.15	167.36	0.33	1.53	1.00	0.03
32.32	170.31	0.34	1.51	1.00	0.03	32.48	153.30	0.26	1.65	1.00	0.03
32.65	128.44	0.18	1.90	1.00	0.04	32.81	172.18	2.00	0.00	1.00	0.00
32.97	136.77	2.00	0.00	1.00	0.00	33.14	133.32	2.00	0.00	1.00	0.00
33.30	142.11	2.00	0.00	1.00	0.00	33.47	158.79	2.00	0.00	1.00	0.00
33.63	165.15	0.32	1.55	1.00	0.03	33.79	157.33	0.28	1.61	1.00	0.03
33.96	137.00	2.00	0.00	1.00	0.00	34.12	112.95	2.00	0.00	1.00	0.00
34.29	105.79	2.00	0.00	1.00	0.00	34.45	128.08	2.00	0.00	1.00	0.00
34.61	171.74	2.00	0.00	1.00	0.00	34.78	155.88	2.00	0.00	1.00	0.00
34.94	189.40	2.00	0.00	1.00	0.00	35.11	213.67	2.00	0.00	1.00	0.00
35.27	238.51	2.00	0.00	1.00	0.00	35.43	259.28	2.00	0.00	1.00	0.00
35.60	276.09	2.00	0.00	1.00	0.00	35.76	286.54	2.00	0.00	1.00	0.00
35.93	292.40	2.00	0.00	1.00	0.00	36.09	301.35	2.00	0.00	1.00	0.00
36.26	306.71	2.00	0.00	1.00	0.00	36.42	313.36	2.00	0.00	1.00	0.00
36.58	318.39	2.00	0.00	1.00	0.00	36.75	326.26	2.00	0.00	1.00	0.00
36.91	333.98	2.00	0.00	1.00	0.00	37.08	338.71	2.00	0.00	1.00	0.00
37.24	341.72	2.00	0.00	1.00	0.00	37.40	344.13	2.00	0.00	1.00	0.00
37.57	349.45	2.00	0.00	1.00	0.00	37.73	356.45	2.00	0.00	1.00	0.00
37.90	361.30	2.00	0.00	1.00	0.00	38.06	369.40	2.00	0.00	1.00	0.00
38.22	377.06	2.00	0.00	1.00	0.00	38.39	383.22	2.00	0.00	1.00	0.00
38.55	385.32	2.00	0.00	1.00	0.00	38.72	385.95	2.00	0.00	1.00	0.00
38.88	387.60	2.00	0.00	1.00	0.00	39.04	383.55	2.00	0.00	1.00	0.00
39.21	373.01	2.00	0.00	1.00	0.00	39.37	358.63	2.00	0.00	1.00	0.00
39.54	348.87	2.00	0.00	1.00	0.00	39.70	341.88	2.00	0.00	1.00	0.00
39.86	338.48	2.00	0.00	1.00	0.00	40.03	327.57	2.00	0.00	1.00	0.00
40.19	308.70	2.00	0.00	1.00	0.00	40.36	281.89	2.00	0.00	1.00	0.00
40.52	254.31	2.00	0.00	1.00	0.00	40.68	222.24	2.00	0.00	1.00	0.00

:: Post-earthquake settlement due to soil liquefaction :: (continued)											
Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)
40.85	190.71	2.00	0.00	1.00	0.00	41.01	155.68	2.00	0.00	1.00	0.00
41.18	142.11	2.00	0.00	1.00	0.00	41.34	160.32	2.00	0.00	1.00	0.00
41.50	140.34	0.23	1.77	1.00	0.03	41.67	134.17	0.21	1.84	1.00	0.04
41.83	119.60	0.16	2.02	1.00	0.04	42.00	193.78	0.51	1.36	1.00	0.03
42.16	77.72	0.53	0.50	1.00	0.01	42.32	78.21	0.46	0.50	1.00	0.01
42.49	79.83	0.46	0.50	1.00	0.01	42.65	84.41	0.49	0.50	1.00	0.01
42.82	87.22	0.52	0.50	1.00	0.01	42.98	88.57	0.52	0.50	1.00	0.01
43.15	87.05	0.51	0.50	1.00	0.01	43.31	87.03	0.50	0.50	1.00	0.01
43.47	85.41	0.49	0.50	1.00	0.01	43.64	85.21	0.51	0.50	1.00	0.01
43.80	80.27	0.51	0.50	1.00	0.01	43.97	76.84	0.50	0.50	1.00	0.01
44.13	75.17	0.49	0.50	1.00	0.01	44.29	78.53	0.49	0.50	1.00	0.01
44.46	83.25	0.49	0.50	1.00	0.01	44.62	86.19	0.50	0.50	1.00	0.01
44.79	86.06	0.50	0.50	1.00	0.01	44.95	81.31	0.50	0.50	1.00	0.01
45.11	76.38	0.49	0.50	1.00	0.01	45.28	78.17	0.46	0.50	1.00	0.01
45.44	92.80	2.00	0.00	1.00	0.00	45.61	264.14	2.00	0.00	1.00	0.00
45.77	127.10	2.00	0.00	1.00	0.00	45.93	157.14	2.00	0.00	1.00	0.00
46.10	193.62	2.00	0.00	1.00	0.00	46.26	212.18	2.00	0.00	1.00	0.00
46.43	213.74	2.00	0.00	1.00	0.00	46.59	217.28	2.00	0.00	1.00	0.00
46.75	232.37	2.00	0.00	1.00	0.00	46.92	269.40	2.00	0.00	1.00	0.00
47.08	322.34	2.00	0.00	1.00	0.00	47.25	374.93	2.00	0.00	1.00	0.00
47.41	390.05	2.00	0.00	1.00	0.00	47.57	377.30	2.00	0.00	1.00	0.00
47.74	335.94	2.00	0.00	1.00	0.00	47.90	308.99	2.00	0.00	1.00	0.00
48.07	297.02	2.00	0.00	1.00	0.00	48.23	313.40	2.00	0.00	1.00	0.00
48.39	318.97	2.00	0.00	1.00	0.00	48.56	317.28	2.00	0.00	1.00	0.00
48.72	296.70	2.00	0.00	1.00	0.00	48.89	260.85	2.00	0.00	1.00	0.00
49.05	225.04	2.00	0.00	1.00	0.00	49.22	213.72	2.00	0.00	1.00	0.00
49.38	221.78	2.00	0.00	1.00	0.00						

Total estimated settlement: 2.31

Abbreviations

- $Q_{tn,cs}$: Equivalent clean sand normalized cone resistance
- FS: Factor of safety against liquefaction
- e_v (%): Post-liquefaction volumetric strain
- DF: e_v depth weighting factor
- Settlement: Calculated settlement

:: Strength loss calculation (Robertson (2009)) ::

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
0.33	12.50	23.59	6.23	146.95	2.95	N/A	N/A
0.49	68.37	129.17	1.24	160.25	1.95	N/A	N/A
0.66	116.07	219.31	1.01	222.20	1.66	N/A	N/A
0.82	161.24	304.68	1.00	304.68	1.45	N/A	N/A
0.98	145.95	275.75	1.00	275.75	1.47	N/A	N/A
1.15	136.88	258.60	1.00	258.60	1.46	N/A	N/A
1.31	128.98	243.65	1.00	243.65	1.46	N/A	N/A
1.48	125.05	236.20	1.00	236.20	1.46	N/A	N/A
1.64	125.16	236.38	1.00	236.38	1.48	N/A	N/A
1.80	130.79	247.02	1.00	247.02	1.47	N/A	N/A
1.97	142.27	268.68	1.00	268.68	1.45	N/A	N/A
2.13	163.54	308.88	1.00	308.88	1.38	N/A	N/A
2.30	195.95	370.12	1.00	370.12	1.32	N/A	N/A
2.46	232.23	435.52	1.00	435.52	1.29	N/A	N/A
2.62	257.96	476.00	1.00	476.00	1.30	N/A	N/A
2.79	268.39	490.39	1.00	490.39	1.32	N/A	N/A
2.95	268.58	485.70	1.00	485.70	1.33	N/A	N/A
3.12	263.78	470.08	1.00	470.08	1.34	N/A	N/A
3.28	257.98	451.41	1.00	451.41	1.34	N/A	N/A
3.45	250.98	430.42	1.00	430.42	1.34	N/A	N/A
3.61	240.25	407.42	1.00	407.42	1.35	N/A	N/A
3.77	223.41	377.95	1.00	377.95	1.38	N/A	N/A
3.94	200.25	339.88	1.00	339.88	1.41	N/A	N/A
4.10	176.41	300.51	1.00	300.51	1.45	N/A	N/A
4.27	155.31	264.68	1.00	264.68	1.48	N/A	N/A
4.43	138.54	233.66	1.00	233.66	1.49	N/A	N/A
4.59	129.10	215.67	1.00	215.67	1.50	N/A	N/A
4.76	123.34	203.54	1.00	203.54	1.50	N/A	N/A
4.92	117.71	195.35	1.00	195.35	1.54	N/A	N/A
5.09	112.77	187.45	1.00	187.45	1.57	0.92	0.92
5.25	108.77	181.37	1.00	181.37	1.59	0.91	0.91
5.41	107.54	176.83	1.00	176.83	1.57	0.91	0.91
5.58	105.91	172.77	1.00	172.77	1.57	0.91	0.91
5.74	106.34	172.39	1.00	172.39	1.57	0.91	0.91
5.91	107.07	175.14	1.00	175.14	1.61	0.91	0.91
6.07	112.16	182.29	1.00	182.29	1.61	0.92	0.92
6.23	117.42	189.51	1.00	189.51	1.60	0.92	0.92
6.40	123.39	196.59	1.00	196.59	1.59	0.93	0.93
6.56	128.66	204.38	1.00	204.38	1.60	0.93	0.93
6.73	137.80	217.40	1.00	217.40	1.60	0.94	0.94
6.89	151.77	236.80	1.00	236.80	1.58	0.96	0.96
7.05	165.77	254.47	1.00	254.47	1.56	0.97	0.97
7.22	171.81	262.29	1.00	262.29	1.56	0.97	0.97
7.38	186.33	282.12	1.00	282.12	1.55	0.98	0.98
7.55	214.29	321.07	1.00	321.07	1.54	1.01	1.01
7.71	259.94	380.47	1.00	380.47	1.50	1.03	1.03
7.87	290.65	419.16	1.00	419.16	1.47	1.05	1.05
8.04	289.92	415.38	1.00	415.38	1.47	1.05	1.05

:: Strength loss calculation (Robertson (2009)) :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
8.20	266.82	382.75	1.00	382.75	1.49	1.04	1.04
8.37	243.14	349.50	1.00	349.50	1.51	1.02	1.02
8.53	233.71	335.73	1.00	335.73	1.53	1.01	1.01
8.69	229.86	328.49	1.00	328.49	1.53	1.01	1.01
8.86	225.40	319.45	1.00	319.45	1.52	1.01	1.01
9.02	222.12	311.36	1.00	311.36	1.51	1.00	1.00
9.19	216.76	303.16	1.00	303.16	1.52	1.00	1.00
9.35	209.17	291.46	1.00	291.46	1.52	0.99	0.99
9.51	187.04	262.70	1.00	262.70	1.56	0.97	0.97
9.68	153.64	220.09	1.00	219.30	1.64	0.94	0.94
9.84	109.50	165.28	1.13	186.09	1.83	0.90	0.90
10.01	84.06	130.49	1.23	160.45	1.94	0.87	0.87
10.17	80.87	123.40	1.19	147.37	1.91	0.86	0.86
10.34	95.57	138.53	1.07	148.85	1.75	0.87	0.87
10.50	107.38	152.00	1.03	156.78	1.69	0.89	0.89
10.66	116.63	163.66	1.02	167.20	1.68	0.90	0.90
10.83	129.16	178.92	1.00	179.28	1.65	0.91	0.91
10.99	145.36	197.73	1.00	197.73	1.60	0.93	0.93
11.16	162.96	218.24	1.00	218.24	1.56	0.94	0.94
11.32	180.62	238.57	1.00	238.57	1.53	0.96	0.96
11.48	199.14	260.08	1.00	260.08	1.50	0.97	0.97
11.65	216.40	279.38	1.00	279.38	1.48	0.98	0.98
11.81	232.82	298.59	1.00	298.59	1.47	0.99	0.99
11.98	247.84	315.53	1.00	315.53	1.45	1.00	1.00
12.14	263.20	333.18	1.00	333.18	1.45	1.01	1.01
12.30	279.13	349.91	1.00	349.91	1.43	1.02	1.02
12.47	292.53	364.62	1.00	364.62	1.42	1.03	1.03
12.63	298.60	371.46	1.00	371.46	1.43	1.03	1.03
12.80	294.23	371.41	1.00	371.41	1.50	1.03	1.03
12.96	270.99	351.80	1.00	351.80	1.64	1.02	1.02
13.12	224.58	301.49	1.11	333.80	1.80	1.00	1.00
13.29	165.78	230.99	1.29	296.96	1.99	0.95	0.95
13.45	113.04	163.72	1.65	269.76	2.19	0.90	0.90
13.62	88.95	131.15	1.98	260.05	2.31	0.87	0.87
13.78	85.05	124.51	1.99	247.56	2.31	0.86	0.86
13.94	95.19	135.27	1.68	226.73	2.20	0.87	0.87
14.11	112.28	153.35	1.37	209.49	2.05	0.89	0.89
14.27	139.79	182.27	1.14	208.66	1.85	0.92	0.92
14.44	172.27	215.96	1.03	221.56	1.68	0.94	0.94
14.60	198.40	243.12	1.00	243.12	1.59	0.96	0.96
14.76	215.56	261.27	1.00	261.27	1.55	0.97	0.97
14.93	228.36	272.33	1.00	272.33	1.49	0.98	0.98
15.09	240.78	285.15	1.00	285.15	1.48	0.99	0.99
15.26	253.07	298.94	1.00	298.94	1.48	0.99	0.99
15.42	259.31	308.46	1.00	308.46	1.54	1.00	1.00
15.58	263.15	313.39	1.00	313.39	1.56	1.00	1.00
15.75	265.45	315.06	1.00	315.06	1.57	1.00	1.00
15.91	268.77	317.63	1.00	317.63	1.56	1.00	1.00

:: Strength loss calculation (Robertson (2009)) :: (continued)							
Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
16.08	270.59	318.75	1.00	318.75	1.57	1.00	1.00
16.24	272.15	320.07	1.00	320.07	1.58	1.01	1.01
16.40	269.35	316.30	1.00	316.30	1.60	1.00	1.00
16.57	260.98	305.97	1.00	305.97	1.61	1.00	1.00
16.73	253.41	296.78	1.00	296.78	1.63	0.99	0.99
16.90	256.51	298.50	1.00	298.50	1.62	0.99	0.99
17.06	261.11	301.12	1.00	301.12	1.58	1.00	1.00
17.23	249.54	285.75	1.00	285.75	1.57	0.99	0.99
17.39	225.37	256.29	1.00	256.29	1.55	0.97	0.97
17.55	212.70	240.32	1.00	240.32	1.53	0.96	0.96
17.72	220.00	245.58	1.00	245.58	1.47	0.96	0.96
17.88	236.02	262.51	1.00	262.51	1.46	0.97	0.97
18.05	245.51	273.02	1.00	273.02	1.48	0.98	0.98
18.21	237.46	265.76	1.00	265.76	1.55	0.97	0.97
18.37	202.72	230.08	1.03	236.64	1.69	0.95	0.95
18.54	143.31	166.26	1.19	197.35	1.90	0.90	0.90
18.70	82.79	98.56	1.60	158.01	2.17	0.83	0.83
18.87	44.12	53.42	2.50	133.32	2.44	0.74	0.74
19.03	34.64	41.56	2.62	108.74	2.47	0.71	0.71
19.19	63.79	73.85	1.44	106.26	2.09	0.79	0.79
19.36	115.68	130.25	1.13	146.98	1.83	0.87	0.87
19.52	171.31	189.45	1.02	194.14	1.68	0.92	0.92
19.69	207.47	227.12	1.00	227.12	1.61	0.95	0.95
19.85	220.51	239.86	1.00	239.86	1.58	0.96	0.96
20.01	219.04	236.88	1.00	236.88	1.56	0.96	0.96
20.18	197.34	214.03	1.00	214.03	1.62	0.94	0.94
20.34	159.47	173.93	1.05	183.17	1.72	0.91	0.91
20.51	108.87	120.63	1.24	149.13	1.95	0.85	0.85
20.67	64.53	72.42	1.65	119.15	2.19	0.78	0.78
20.83	50.78	57.26	2.08	118.98	2.34	0.75	0.75
21.00	83.61	92.33	1.40	129.22	2.07	0.82	0.82
21.16	134.42	145.61	1.14	165.94	1.84	0.88	0.88
21.33	175.70	187.26	1.03	192.20	1.68	0.92	0.92
21.49	182.05	193.30	1.02	197.31	1.67	0.92	0.92
21.65	169.14	180.06	1.07	192.83	1.75	0.91	0.91
21.82	159.18	169.89	1.13	191.65	1.83	0.90	0.90
21.98	165.41	175.78	1.12	196.63	1.82	0.91	0.91
22.15	182.34	192.22	1.07	206.45	1.75	0.92	0.92
22.31	202.92	212.14	1.02	217.29	1.68	0.94	0.94
22.47	215.45	223.48	1.00	223.48	1.61	0.95	0.95
22.64	215.01	221.97	1.00	221.97	1.59	0.95	0.95
22.80	195.03	201.47	1.01	202.58	1.65	0.93	0.93
22.97	166.26	172.44	1.09	188.22	1.78	0.91	0.91
23.13	149.20	154.85	1.15	178.11	1.86	0.89	0.89
23.30	140.76	145.90	1.19	173.87	1.90	0.88	0.88
23.46	126.19	130.70	1.26	165.16	1.97	0.87	0.87
23.62	103.55	107.32	1.43	153.77	2.09	0.84	0.84
23.79	89.89	93.03	1.61	149.70	2.18	0.82	0.82

:: Strength loss calculation (Robertson (2009)) :: (continued)							
Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
23.95	103.36	106.21	1.42	150.93	2.08	0.84	0.84
24.12	132.86	135.06	1.18	159.19	1.89	0.87	0.87
24.28	162.46	163.51	1.05	171.54	1.72	0.90	0.90
24.44	182.46	182.42	1.00	182.42	1.62	0.92	0.92
24.61	197.10	196.37	1.00	196.37	1.59	0.93	0.93
24.77	210.77	209.34	1.00	209.34	1.57	0.94	0.94
24.94	228.87	226.56	1.00	226.56	1.55	0.95	0.95
25.10	252.86	249.55	1.00	249.55	1.52	0.96	0.96
25.26	280.02	275.58	1.00	275.58	1.50	0.98	0.98
25.43	306.41	300.73	1.00	300.73	1.49	1.00	1.00
25.59	329.48	322.52	1.00	322.52	1.48	1.01	1.01
25.76	349.64	341.23	1.00	341.23	1.47	1.02	1.02
25.92	363.21	353.49	1.00	353.49	1.46	1.02	1.02
26.08	368.54	357.74	1.00	357.74	1.45	1.02	1.02
26.25	363.71	352.20	1.00	352.20	1.47	1.02	1.02
26.41	348.04	336.41	1.00	336.41	1.51	1.01	1.01
26.58	328.04	316.47	1.00	316.47	1.58	1.00	1.00
26.74	312.07	300.43	1.00	300.43	1.64	0.99	0.99
26.90	303.44	291.23	1.00	290.32	1.64	0.99	0.99
27.07	299.23	286.11	1.00	286.11	1.59	0.99	0.99
27.23	289.50	275.86	1.00	275.86	1.55	0.98	0.98
27.40	260.90	247.91	1.00	247.91	1.62	0.96	0.96
27.56	201.76	191.12	1.15	219.08	1.85	0.92	0.92
27.72	130.46	122.76	1.52	186.94	2.14	0.86	0.86
27.89	77.57	72.08	2.47	177.90	2.44	0.78	0.78
28.05	59.11	54.31	2.90	157.67	2.53	0.74	0.74
28.22	91.24	84.39	1.61	135.60	2.17	0.80	0.80
28.38	122.46	113.53	1.17	133.11	1.88	0.85	0.85
28.54	131.27	121.57	1.05	128.25	1.73	0.86	0.86
28.71	93.79	86.08	1.16	99.60	1.86	0.81	0.81
28.87	53.37	48.04	1.46	70.31	2.10	0.73	0.73
29.04	30.49	26.58	2.07	55.13	2.34	0.07	0.66
29.20	20.84	17.56	2.61	45.84	2.47	0.05	0.61
29.36	18.15	15.02	3.08	46.23	2.56	0.05	0.59
29.53	18.26	15.04	3.80	57.16	2.67	0.18	1.07
29.69	20.20	16.73	4.56	76.30	2.77	1.19	1.19
29.86	27.47	23.28	4.10	95.38	2.71	1.66	1.66
30.02	56.63	49.96	1.98	98.88	2.31	0.73	0.73
30.19	85.91	76.71	1.44	110.27	2.09	0.79	0.79
30.35	101.30	90.58	1.35	121.91	2.03	0.81	0.81
30.51	94.96	84.37	1.50	126.17	2.12	0.80	0.80
30.68	98.61	87.36	1.50	130.91	2.12	0.81	0.81
30.84	101.17	89.49	1.42	126.69	2.08	0.81	0.81
31.01	92.16	81.05	1.45	117.52	2.10	0.80	0.80
31.17	64.46	55.71	1.86	103.60	2.27	0.75	0.75
31.33	53.87	45.97	2.23	102.38	2.38	0.72	0.72
31.50	48.25	40.72	2.61	106.31	2.47	0.71	0.71
31.66	66.19	56.62	1.94	109.87	2.30	0.75	0.75

:: Strength loss calculation (Robertson (2009)) :: (continued)							
Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
31.83	80.92	69.55	1.72	119.29	2.22	0.78	0.78
31.99	97.45	83.83	1.71	143.42	2.22	0.80	0.80
32.15	110.98	95.31	1.76	167.36	2.23	0.82	0.82
32.32	106.32	90.72	1.88	170.31	2.28	0.81	0.81
32.48	94.32	79.95	1.92	153.30	2.29	0.80	0.80
32.65	63.28	52.54	2.44	128.44	2.43	0.74	0.74
32.81	49.32	40.17	3.11	125.10	2.56	0.71	0.71
32.97	56.36	46.09	2.81	129.60	2.51	0.72	0.72
33.14	84.29	70.30	1.90	133.32	2.28	0.78	0.78
33.30	126.89	107.82	1.32	142.11	2.01	0.84	0.84
33.47	166.55	143.21	1.11	158.79	1.80	0.88	0.88
33.63	186.21	160.97	1.03	165.15	1.68	0.90	0.90
33.79	177.67	153.12	1.03	157.33	1.68	0.89	0.89
33.96	147.79	126.13	1.09	137.00	1.77	0.86	0.86
34.12	107.02	89.56	1.26	112.95	1.97	0.81	0.81
34.29	67.36	54.44	1.94	105.79	2.30	0.75	0.75
34.45	38.21	29.17	4.39	128.08	2.75	2.07	2.07
34.61	63.93	50.49	2.92	147.40	2.53	0.74	0.74
34.78	118.36	96.79	1.61	155.88	2.18	0.82	0.82
34.94	187.26	156.29	1.21	189.40	1.92	0.89	0.89
35.11	224.41	188.18	1.14	213.67	1.84	0.92	0.92
35.27	252.82	211.82	1.13	238.51	1.83	0.94	0.94
35.43	280.57	235.13	1.10	259.28	1.79	0.96	0.96
35.60	309.38	259.81	1.06	276.09	1.74	0.97	0.97
35.76	332.71	280.02	1.02	286.54	1.68	0.98	0.98
35.93	347.85	292.86	1.00	292.40	1.64	0.99	0.99
36.09	358.41	301.35	1.00	301.35	1.63	1.00	1.00
36.26	365.67	306.71	1.00	306.71	1.63	1.00	1.00
36.42	374.60	313.36	1.00	313.36	1.63	1.00	1.00
36.58	382.96	319.41	1.00	318.39	1.64	1.01	1.01
36.75	392.12	326.08	1.00	326.26	1.65	1.01	1.01
36.91	402.25	333.98	1.00	333.98	1.64	1.01	1.01
37.08	408.59	338.71	1.00	338.71	1.63	1.02	1.02
37.24	412.82	341.72	1.00	341.72	1.62	1.02	1.02
37.40	415.92	344.13	1.00	344.13	1.60	1.02	1.02
37.57	422.88	349.45	1.00	349.45	1.58	1.02	1.02
37.73	432.18	356.45	1.00	356.45	1.58	1.02	1.02
37.90	440.07	361.30	1.00	361.30	1.60	1.03	1.03
38.06	451.35	369.40	1.00	369.40	1.61	1.03	1.03
38.22	461.79	377.06	1.00	377.06	1.61	1.03	1.03
38.39	470.09	383.22	1.00	383.22	1.60	1.04	1.04
38.55	473.28	385.32	1.00	385.32	1.59	1.04	1.04
38.72	474.64	385.95	1.00	385.95	1.58	1.04	1.04
38.88	476.97	387.60	1.00	387.60	1.57	1.04	1.04
39.04	472.83	383.55	1.00	383.55	1.56	1.04	1.04
39.21	459.76	373.01	1.00	373.01	1.54	1.03	1.03
39.37	442.89	358.63	1.00	358.63	1.53	1.02	1.02
39.54	431.39	348.87	1.00	348.87	1.52	1.02	1.02

:: Strength loss calculation (Robertson (2009)) :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
39.70	424.63	341.88	1.00	341.88	1.54	1.02	1.02
39.86	421.34	338.48	1.00	338.48	1.54	1.01	1.01
40.03	409.01	327.57	1.00	327.57	1.55	1.01	1.01
40.19	387.10	308.70	1.00	308.70	1.56	1.00	1.00
40.36	355.08	281.89	1.00	281.89	1.57	0.98	0.98
40.52	322.48	254.31	1.00	254.31	1.61	0.97	0.97
40.68	280.21	218.47	1.02	222.24	1.67	0.94	0.94
40.85	221.81	168.58	1.13	190.71	1.83	0.90	0.90
41.01	149.01	108.71	1.43	155.68	2.09	0.84	0.84
41.18	97.38	67.87	2.09	142.11	2.34	0.77	0.77
41.34	64.36	42.94	3.00	128.66	2.54	0.71	0.71
41.50	52.84	34.77	3.06	106.47	2.55	0.69	0.69
41.67	41.28	26.55	3.26	86.63	2.59	0.66	0.66
41.83	36.52	23.21	3.28	76.14	2.59	0.64	0.64
42.00	31.46	19.40	3.97	77.08	2.70	1.36	1.36
42.16	27.40	16.39	4.74	77.72	2.80	1.16	1.16
42.32	24.14	14.11	5.54	78.21	2.88	1.01	1.01
42.49	24.20	14.11	5.66	79.83	2.90	1.01	1.01
42.65	25.76	15.08	5.60	84.41	2.89	1.08	1.08
42.82	27.07	15.88	5.49	87.22	2.88	1.13	1.13
42.98	27.47	16.09	5.51	88.57	2.88	1.15	1.15
43.15	26.89	15.66	5.56	87.05	2.89	1.12	1.12
43.31	26.44	15.32	5.68	87.03	2.90	1.09	1.09
43.47	26.24	15.14	5.64	85.41	2.89	1.08	1.08
43.64	26.79	15.44	5.52	85.21	2.88	1.10	1.10
43.80	26.89	15.46	5.19	80.27	2.85	1.10	1.10
43.97	26.70	15.28	5.03	76.84	2.83	1.09	1.09
44.13	25.96	14.77	5.09	75.17	2.83	1.06	1.06
44.29	26.03	14.76	5.32	78.53	2.86	1.05	1.05
44.46	26.37	14.93	5.58	83.25	2.89	1.07	1.07
44.62	26.70	15.09	5.71	86.19	2.90	1.08	1.08
44.79	26.87	15.15	5.68	86.06	2.90	1.08	1.08
44.95	26.79	15.05	5.40	81.31	2.87	1.08	1.08
45.11	26.23	14.65	5.21	76.38	2.85	1.05	1.05
45.28	25.20	13.96	5.60	78.17	2.89	1.00	1.00
45.44	27.49	15.35	6.05	92.80	2.93	1.10	1.10
45.61	48.21	28.78	3.88	111.56	2.68	2.01	2.01
45.77	102.45	67.21	1.89	127.10	2.28	0.77	0.77
45.93	180.51	126.07	1.25	157.14	1.96	0.86	0.86
46.10	247.25	178.33	1.09	193.62	1.77	0.91	0.91
46.26	274.77	198.87	1.07	212.18	1.74	0.93	0.93
46.43	266.17	189.39	1.13	213.74	1.83	0.92	0.92
46.59	258.74	181.09	1.20	217.28	1.91	0.91	0.91
46.75	281.98	197.99	1.17	232.37	1.88	0.93	0.93
46.92	352.57	253.76	1.06	269.40	1.74	0.97	0.97
47.08	436.24	322.34	1.00	322.34	1.58	1.01	1.01
47.25	497.24	374.93	1.00	374.93	1.45	1.03	1.03
47.41	513.87	390.05	1.00	390.05	1.41	1.04	1.04

:: Strength loss calculation (Robertson (2009)) :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
47.57	498.20	377.30	1.00	377.30	1.41	1.03	1.03
47.74	451.53	335.94	1.00	335.94	1.49	1.01	1.01
47.90	423.46	308.99	1.00	308.99	1.59	1.00	1.00
48.07	403.92	289.03	1.03	297.02	1.68	0.99	0.99
48.23	425.28	303.31	1.03	313.40	1.69	1.00	1.00
48.39	438.61	313.54	1.02	318.97	1.67	1.00	1.00
48.56	441.71	317.28	1.00	317.28	1.63	1.00	1.00
48.72	414.77	296.33	1.00	296.70	1.65	0.99	0.99
48.89	353.44	248.26	1.05	260.85	1.72	0.96	0.96
49.05	293.51	201.81	1.12	225.04	1.81	0.93	0.93
49.22	281.59	193.64	1.10	213.72	1.80	0.92	0.92
49.38	299.67	207.84	1.07	221.78	1.74	0.94	0.94

Abbreviations

q_t :	Total cone resistance
K_c :	Cone resistance correction factor due to fines
$Q_{tn,cs}$:	Adjusted and corrected cone resistance due to fines
I_c :	Soil behavior type index
$S_{u(liq)}/\sigma'_v$:	Calculated liquefied undrained strength ratio
$S_{u(peak)}/\sigma'_v$:	Calculated peak undrained strength ratio

LIQUEFACTION ANALYSIS REPORT

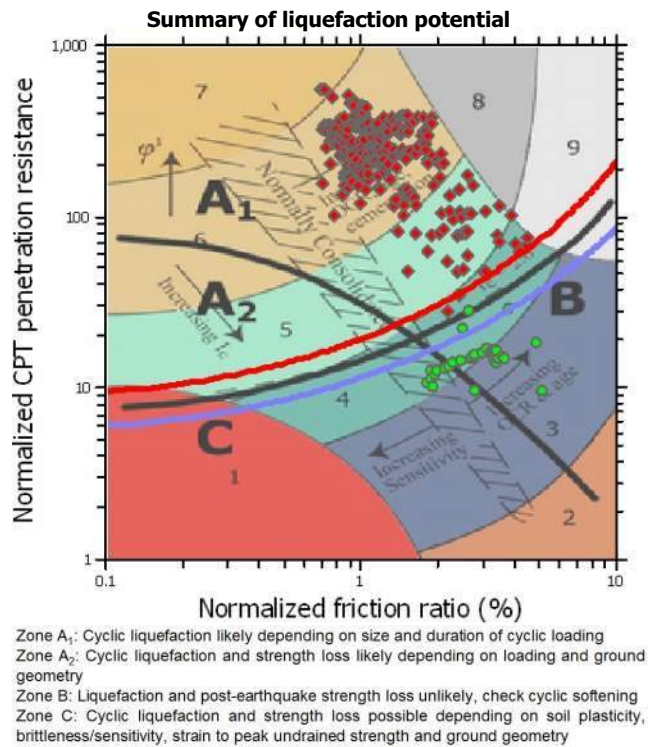
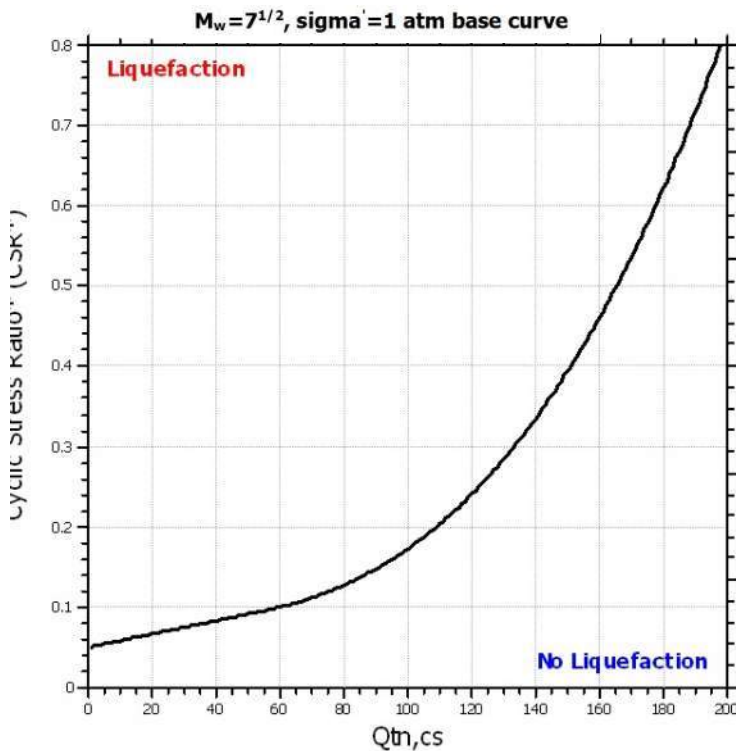
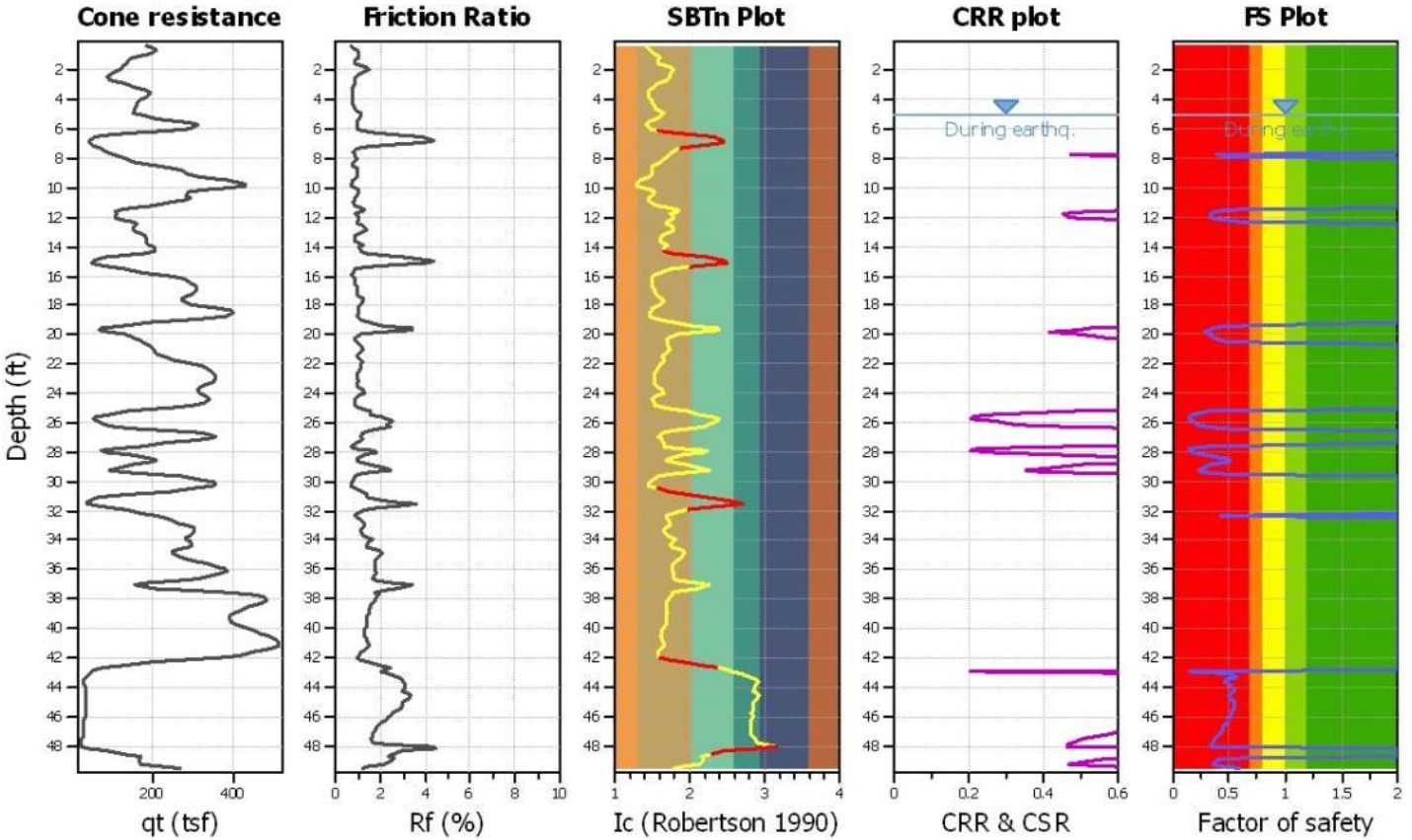
Project title :

Location :

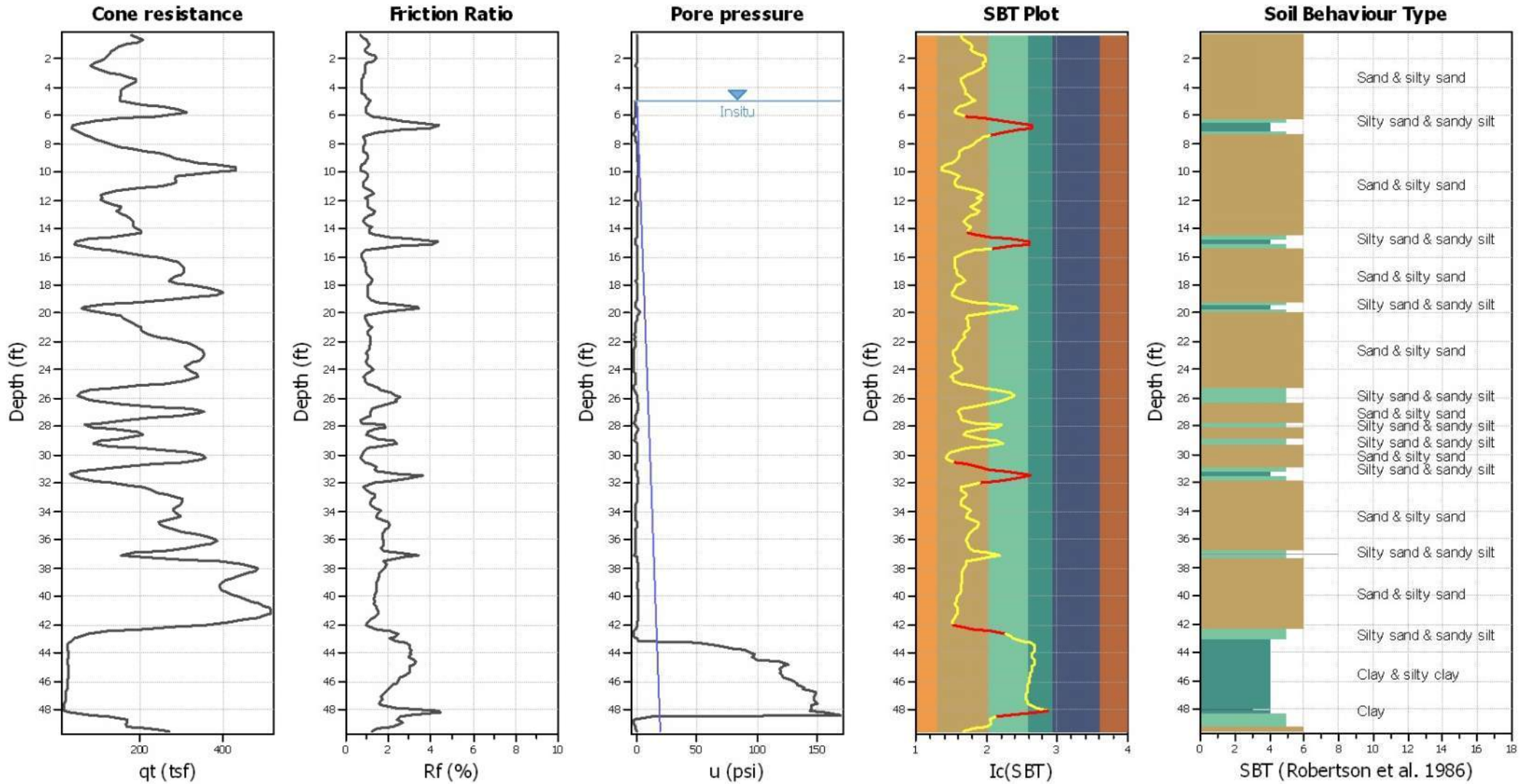
CPT file : CPT-02

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	5.00 ft	Use fill:	No	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	5.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w :	8.10	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	1.27	Unit weight calculation:	Based on SBT	K_0 applied:	No		



CPT basic interpretation plo



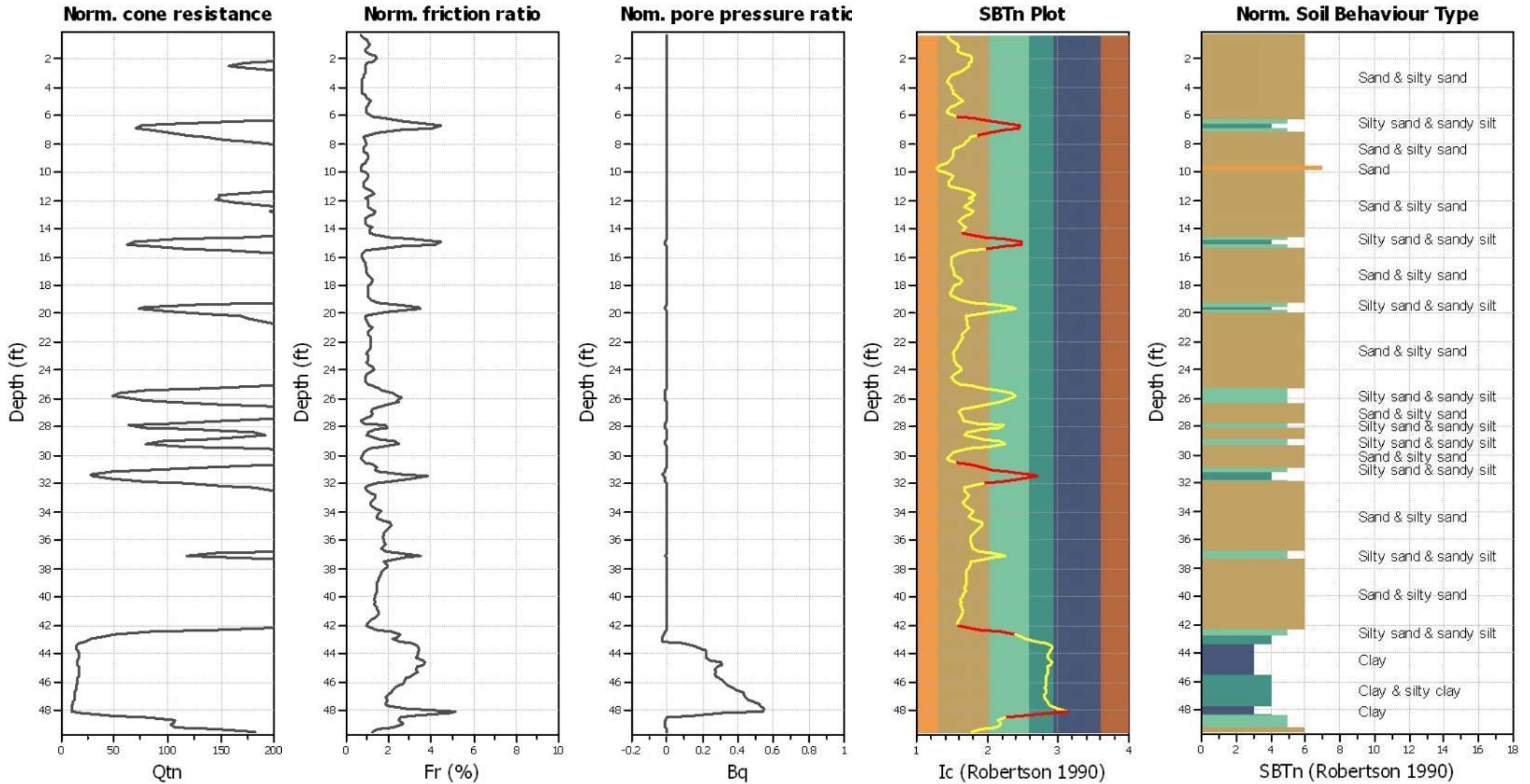
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	5.00 ft	Fill weight:	N/A
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _v applied:	No
Earthquake magnitude M _w :	8.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	1.27	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	5.00 ft	Fill height:	N/A	Limit depth:	N/A

SBT legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

CPT basic interpretation plots (normaliz



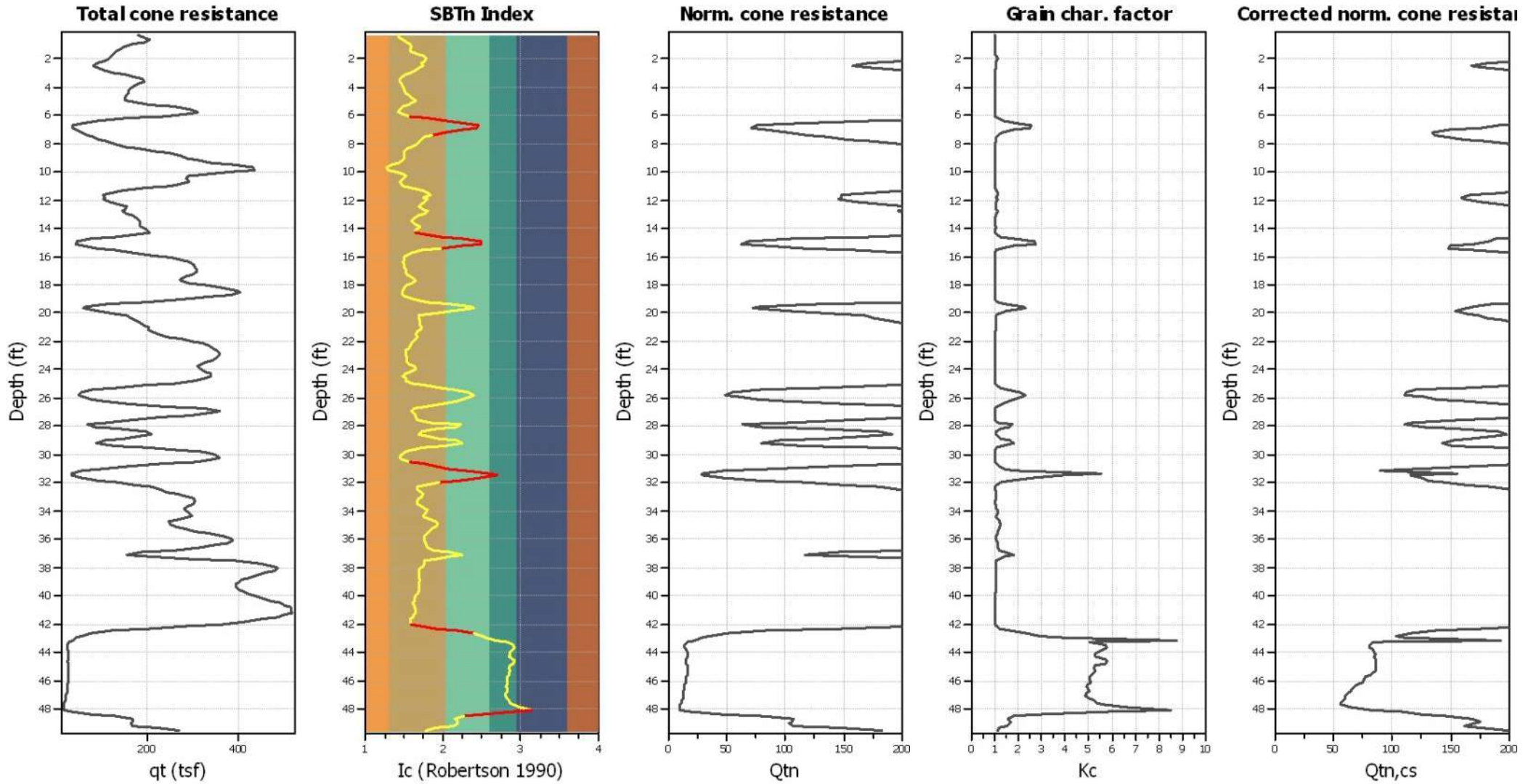
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	5.00 ft	Fill weight:	N/A
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _v applied:	No
Earthquake magnitude M _w :	8.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	1.27	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	5.00 ft	Fill height:	N/A	Limit depth:	N/A

SBTn legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

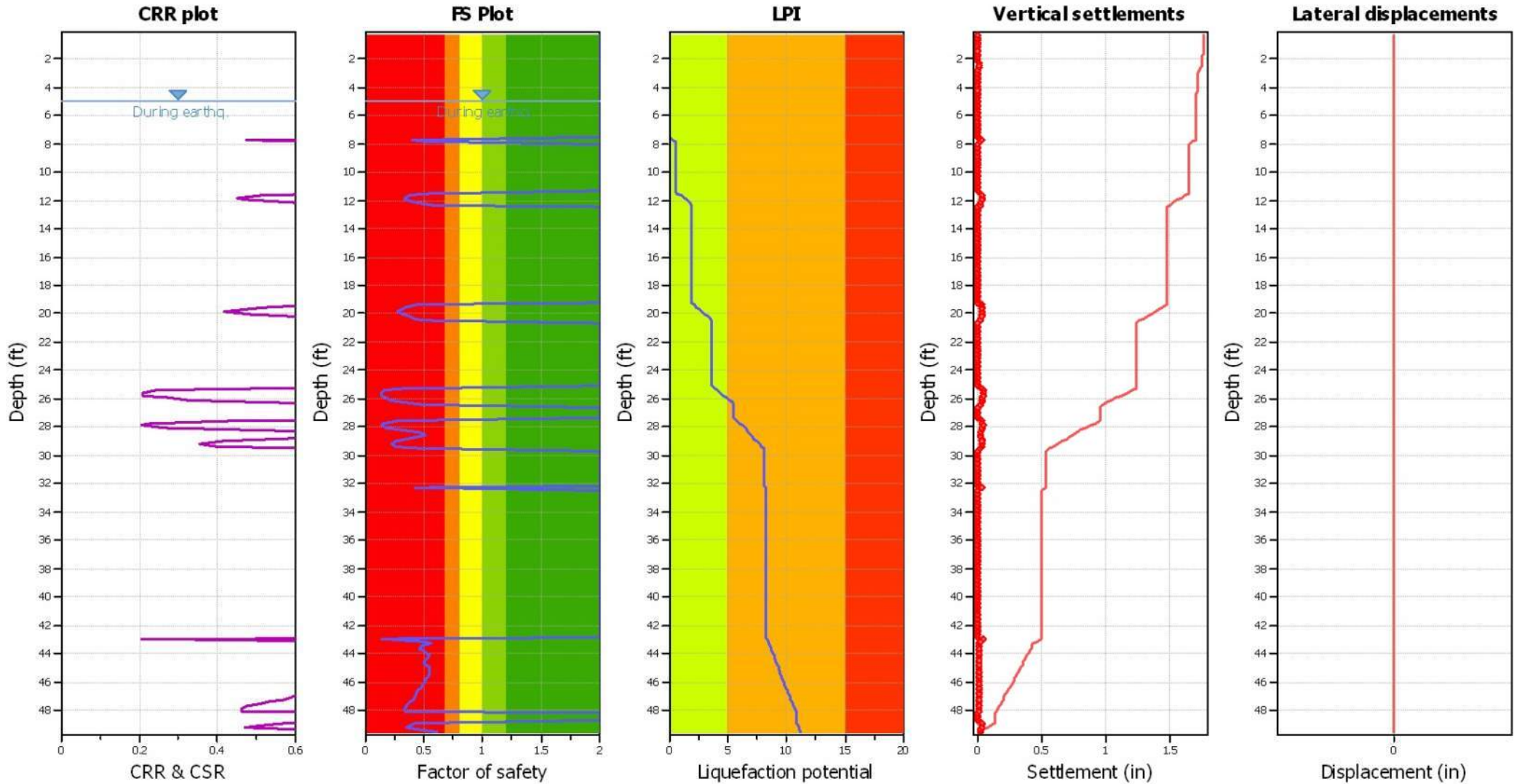
Liquefaction analysis overall plots (intermediate resu



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	5.00 ft	Fill weight:	N/A
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _v applied:	No
Earthquake magnitude M _w :	8.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	1.27	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	5.00 ft	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plot



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (earthq.):	5.00 ft	Fill weight:	N/A
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_v applied:	No
Earthquake magnitude M_w :	8.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	1.27	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	5.00 ft	Fill height:	N/A	Limit depth:	N/A

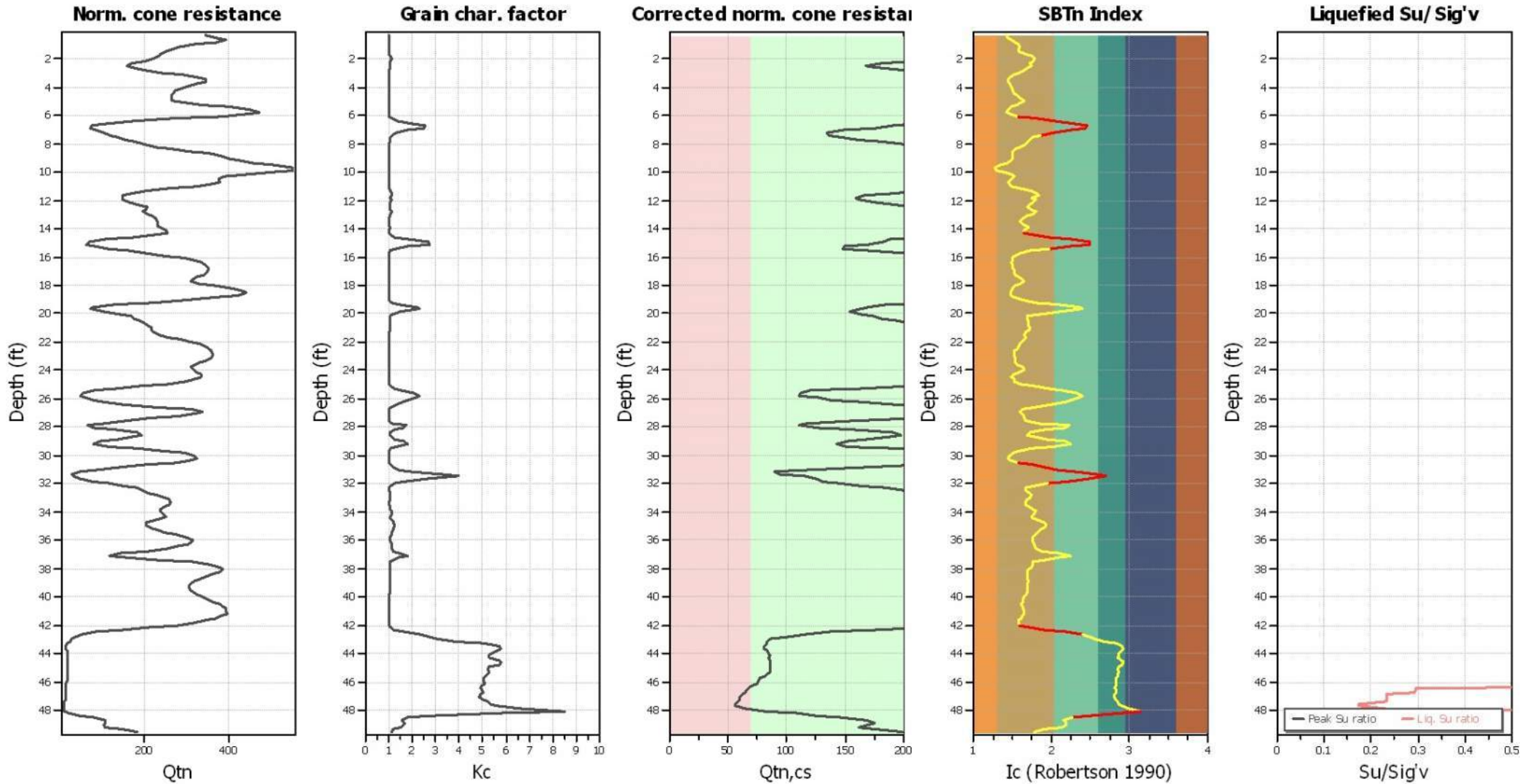
F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	5.00 ft	Fill weight:	N/A
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _c applied:	No
Earthquake magnitude M _w :	8.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	1.27	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	5.00 ft	Fill height:	N/A	Limit depth:	N/A

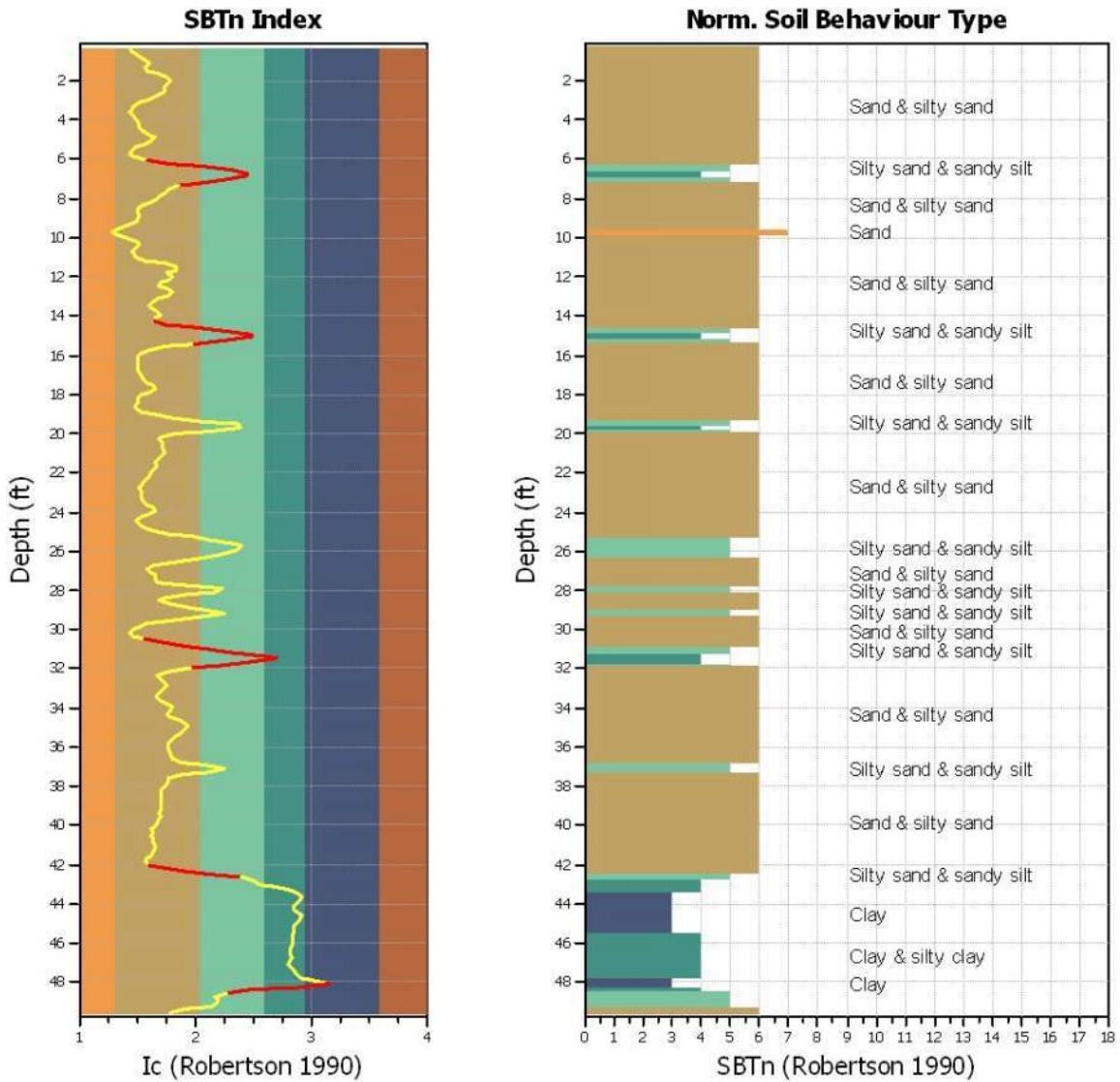
TRANSITION LAYER DETECTION ALGORITHM REPORT

Summary Details & Plots

Short description

The software will delete data when the cone is in transition from either clay to sand or vice-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between $1.80 < I_c < 3.0$) and a rate of change of I_c . Transitions typically occur when the rate of change of I_c is fast (i.e. ΔI_c is small).

The SBT_n plot below, displays in red the detected transition layers based on the parameters listed below the graphs.



Transition layer algorithm properties		General statistics	
I_c minimum check value:	1.70	Total points in CPT file:	301
I_c maximum check value:	3.00	Total points excluded:	37
I_c change ratio value:	0.0250	Exclusion percentage:	12.29%
Minimum number of points in layer:	4	Number of layers detected:	8

Transition layer No	Number of points	Depth	SBT _n number	SBT _n description
Transition layer 1	4	Start depth: 6.23 (ft)	6	Sand & silty sand
		End depth: 6.73 (ft)	4	Clay & silty clay
Transition layer 2	5	Start depth: 6.89 (ft)	4	Clay & silty clay
		End depth: 7.55 (ft)	6	Sand & silty sand
Transition layer 3	4	Start depth: 14.44 (ft)	6	Sand & silty sand
		End depth: 14.93 (ft)	4	Clay & silty clay
Transition layer 4	4	Start depth: 15.09 (ft)	4	Clay & silty clay
		End depth: 15.58 (ft)	6	Sand & silty sand
Transition layer 5	6	Start depth: 30.68 (ft)	6	Sand & silty sand
		End depth: 31.50 (ft)	4	Clay & silty clay
Transition layer 6	5	Start depth: 31.50 (ft)	4	Clay & silty clay
		End depth: 32.15 (ft)	6	Sand & silty sand
Transition layer 7	5	Start depth: 42.16 (ft)	6	Sand & silty sand
		End depth: 42.82 (ft)	4	Clay & silty clay
Transition layer 8	4	Start depth: 48.23 (ft)	3	Clay
		End depth: 48.72 (ft)	5	Silty sand & sandy silt

Start depth: Depth where the transition layer begins

End depth: Depth where the transition layer ends

:: Field input data ::						
Point ID	Depth (ft)	q _c (tsf)	f _s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
1	0.33	170.40	1.10	0.00	1.83	124.88
2	0.49	203.30	1.70	0.00	2.16	126.75
3	0.66	217.90	2.10	0.00	2.55	128.10
4	0.82	199.40	2.00	-0.10	3.36	128.31
5	0.98	164.90	2.00	0.00	3.98	127.09
6	1.15	143.60	1.40	0.00	4.31	125.62
7	1.31	140.90	1.20	0.00	3.94	123.83
8	1.48	130.70	1.10	0.00	4.08	123.32
9	1.64	126.00	1.20	0.00	5.60	124.53
10	1.80	122.00	1.90	0.00	7.16	125.89
11	1.97	120.40	2.00	0.00	7.85	125.75
12	2.13	106.20	1.20	0.00	7.53	123.72
13	2.30	87.00	0.80	0.10	6.70	120.51
14	2.46	81.10	0.70	-0.50	6.84	119.12
15	2.62	82.60	0.80	0.00	6.37	119.58
16	2.79	102.50	0.90	0.00	5.29	121.13
17	2.95	130.90	1.10	0.00	4.12	122.81
18	3.12	151.00	1.30	0.00	3.15	124.27
19	3.28	176.90	1.40	0.00	2.42	125.13
20	3.45	192.20	1.40	0.00	2.06	125.69
21	3.61	198.70	1.50	0.00	2.02	125.73
22	3.77	184.80	1.40	0.00	2.28	125.45
23	3.94	168.20	1.30	-0.10	2.61	124.72
24	4.10	157.80	1.20	-0.10	2.88	124.20
25	4.27	157.10	1.20	0.00	3.00	123.95
26	4.43	158.00	1.20	0.00	3.08	123.94
27	4.59	156.60	1.20	0.00	3.70	124.68
28	4.76	150.20	1.60	0.00	4.44	125.50
29	4.92	150.20	1.70	0.00	5.31	126.53
30	5.09	152.70	1.90	-0.30	4.67	127.51
31	5.25	210.50	2.10	-1.30	3.59	128.83
32	5.41	259.40	2.40	-0.80	2.64	130.39
33	5.58	295.30	2.90	-0.40	2.14	131.46
34	5.74	316.80	2.90	-0.30	1.92	132.07
35	5.91	322.70	2.90	-0.40	2.42	132.00
36	6.07	240.10	3.00	-0.30	4.11	131.50
37	6.23	152.60	2.90	-1.40	8.13	130.03
38	6.40	75.10	2.40	-2.00	14.34	127.70
39	6.56	48.20	1.90	-1.90	23.44	125.32
40	6.73	39.00	1.90	-1.30	28.71	123.45
41	6.89	33.50	1.50	-0.80	28.12	122.09
42	7.05	40.70	1.10	-0.60	20.99	120.41
43	7.22	57.50	0.80	-1.40	13.44	118.79
44	7.38	72.20	0.60	-1.80	9.23	118.07
45	7.55	84.00	0.70	-1.10	7.30	118.47
46	7.71	96.30	0.80	-0.20	6.68	120.09
47	7.87	110.50	1.00	-0.20	6.11	121.78
48	8.04	129.30	1.20	-0.10	5.53	123.48

:: Field input data :: (continued)

Point ID	Depth (ft)	q _c (tsf)	f _s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
49	8.20	150.70	1.40	-0.10	4.26	124.27
50	8.37	179.80	1.20	0.10	3.45	125.76
51	8.53	214.80	1.80	0.30	2.93	127.69
52	8.69	254.70	2.40	0.50	2.93	129.82
53	8.86	275.10	2.70	0.60	2.96	131.21
54	9.02	284.10	3.00	0.90	2.83	131.88
55	9.19	305.40	3.00	0.90	2.51	132.38
56	9.35	338.10	3.10	1.10	1.92	132.76
57	9.51	375.60	3.20	1.30	0.89	132.66
58	9.68	439.00	2.50	1.30	0.27	133.02
59	9.84	478.10	3.20	1.50	0.41	133.35
60	10.01	379.30	3.60	1.90	1.53	133.90
61	10.17	304.40	3.60	1.40	2.78	133.24
62	10.34	281.30	2.90	0.80	3.07	132.05
63	10.50	280.80	2.40	0.70	2.68	131.13
64	10.66	288.20	2.60	0.50	2.24	130.71
65	10.83	301.20	2.40	0.70	2.29	130.21
66	10.99	250.50	2.00	0.60	2.55	128.80
67	11.16	196.00	1.60	0.30	3.94	127.50
68	11.32	153.60	1.80	0.00	6.90	126.46
69	11.48	90.80	1.80	-0.30	8.75	125.04
70	11.65	110.40	1.00	-0.30	8.79	123.18
71	11.81	116.70	0.90	-0.20	7.05	121.47
72	11.98	100.50	1.00	-0.50	8.12	122.35
73	12.14	101.80	1.40	1.70	7.48	123.69
74	12.30	159.10	1.40	1.10	6.26	125.01
75	12.47	168.10	1.50	0.90	5.78	125.89
76	12.63	143.60	1.80	0.70	7.12	126.95
77	12.80	141.70	2.20	0.80	8.06	127.51
78	12.96	154.60	2.00	0.70	7.33	127.52
79	13.12	168.00	1.70	0.50	5.94	127.06
80	13.29	180.00	1.70	0.50	4.83	126.50
81	13.45	185.60	1.50	0.50	4.34	126.27
82	13.62	185.40	1.50	0.50	4.59	126.57
83	13.78	178.50	1.90	0.40	5.47	127.81
84	13.94	186.50	2.40	0.40	6.11	129.04
85	14.11	200.30	2.50	0.40	5.28	128.98
86	14.27	216.30	1.70	0.40	5.32	129.36
87	14.44	200.10	2.70	0.30	6.98	129.36
88	14.60	126.90	2.80	-0.10	12.07	129.34
89	14.76	66.90	2.50	-1.10	20.03	127.34
90	14.93	43.90	1.90	-0.70	29.87	125.16
91	15.09	34.20	1.90	-0.40	30.20	123.81
92	15.26	54.50	1.60	0.60	20.70	123.62
93	15.42	97.10	1.20	0.60	12.13	123.41
94	15.58	125.20	1.20	0.00	6.79	123.50
95	15.75	170.90	1.20	-0.10	4.34	124.75
96	15.91	221.00	1.50	0.00	3.16	126.66

:: Field input data :: (continued)						
Point ID	Depth (ft)	q _c (tsf)	f _s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
97	16.08	254.90	2.00	0.00	2.86	128.70
98	16.24	278.60	2.40	0.20	2.80	130.07
99	16.40	293.80	2.50	0.20	2.74	130.81
100	16.57	300.50	2.60	0.20	2.80	131.36
101	16.73	306.00	2.90	0.20	2.95	131.85
102	16.90	309.10	3.00	0.20	3.12	132.20
103	17.06	307.40	3.00	0.20	3.22	132.27
104	17.23	302.20	3.00	0.10	3.47	132.21
105	17.39	285.30	3.00	0.10	4.07	132.33
106	17.55	267.00	3.30	0.00	4.97	132.83
107	17.72	266.30	3.80	-0.20	5.12	132.97
108	17.88	283.60	3.20	-0.10	4.32	133.00
109	18.05	327.10	3.10	0.20	3.44	133.41
110	18.21	367.10	4.00	0.60	2.94	134.36
111	18.37	400.50	4.20	0.80	2.73	135.17
112	18.54	414.40	4.10	1.00	2.59	135.22
113	18.70	389.10	4.00	0.80	2.63	134.54
114	18.87	344.30	3.30	0.80	3.23	133.57
115	19.03	281.00	3.10	0.50	4.79	132.38
116	19.19	191.50	3.10	-0.40	8.13	130.81
117	19.36	105.00	2.40	-1.20	14.73	128.78
118	19.52	54.50	2.20	-1.30	24.82	126.52
119	19.69	41.80	2.20	0.10	25.97	125.89
120	19.85	90.20	2.00	2.40	16.33	125.85
121	20.01	141.80	1.40	1.60	9.03	125.29
122	20.18	161.10	1.20	0.40	6.09	124.69
123	20.34	164.00	1.40	0.20	5.92	125.34
124	20.51	166.80	1.70	-0.10	6.29	126.55
125	20.67	182.40	1.90	-0.70	6.33	127.81
126	20.83	202.90	2.20	-0.90	6.37	128.79
127	21.00	199.20	2.40	-1.10	6.79	129.94
128	21.16	207.40	2.90	-1.20	6.18	129.22
129	21.33	204.10	1.50	-1.30	5.61	128.97
130	21.49	217.60	2.10	-1.40	5.11	129.34
131	21.65	248.80	3.10	-1.30	5.42	131.23
132	21.82	269.60	3.20	-1.40	5.15	132.54
133	21.98	300.30	3.40	-1.30	4.62	133.19
134	22.15	322.90	3.70	-1.20	4.30	133.84
135	22.31	335.60	3.90	-1.20	4.02	134.15
136	22.47	344.50	3.70	-1.50	3.61	134.03
137	22.64	354.20	3.40	-1.40	3.20	133.74
138	22.80	355.90	3.40	-1.60	3.06	133.70
139	22.97	357.80	3.60	-1.50	3.21	133.91
140	23.13	355.00	3.70	-1.60	3.31	133.88
141	23.30	344.60	3.40	-1.60	3.33	133.46
142	23.46	328.30	3.10	-1.60	3.50	132.98
143	23.62	309.80	3.20	-1.60	4.03	133.11
144	23.79	307.40	3.70	-1.50	4.79	133.84

:: Field input data :: (continued)

Point ID	Depth (ft)	q _c (tsf)	f _s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
145	23.95	313.10	4.20	-1.50	5.13	134.51
146	24.12	326.50	4.20	-1.40	4.09	133.69
147	24.28	340.40	2.30	-1.30	3.25	132.98
148	24.44	344.50	3.10	-1.30	2.72	132.28
149	24.61	333.90	3.30	-1.20	3.06	132.28
150	24.77	309.00	2.40	-0.80	3.24	131.30
151	24.94	270.90	2.20	-1.10	4.69	130.83
152	25.10	201.60	3.20	-1.70	7.52	129.66
153	25.26	117.70	1.90	-2.00	12.10	127.62
154	25.43	78.70	1.20	-1.50	16.42	123.16
155	25.59	53.70	0.90	-0.90	23.59	121.46
156	25.76	38.40	1.50	-0.10	26.44	120.95
157	25.92	58.50	1.10	0.30	24.75	123.61
158	26.08	88.30	2.10	0.70	20.62	125.54
159	26.25	94.50	2.40	0.60	18.50	128.28
160	26.41	126.70	3.00	1.20	12.43	130.76
161	26.58	256.10	3.70	1.50	7.51	132.91
162	26.74	347.90	3.90	1.20	4.89	134.33
163	26.90	367.30	4.10	0.70	4.18	134.86
164	27.07	352.80	4.20	0.40	4.67	134.75
165	27.23	298.00	3.90	-0.20	5.09	133.01
166	27.40	230.60	2.00	-0.80	5.22	129.32
167	27.56	166.50	0.70	-1.30	5.42	123.90
168	27.72	107.20	0.80	-1.50	8.94	120.72
169	27.89	60.10	1.10	-1.10	20.00	122.15
170	28.05	41.50	1.80	0.20	18.15	124.57
171	28.22	156.20	1.90	1.20	11.09	126.85
172	28.38	214.70	1.90	-0.10	6.61	128.09
173	28.54	215.70	2.10	-0.30	5.90	128.24
174	28.71	193.70	1.90	-0.70	7.71	128.71
175	28.87	156.40	2.50	-0.90	11.54	128.45
176	29.04	94.30	2.40	-1.50	18.00	128.07
177	29.20	69.90	2.30	0.00	20.73	126.89
178	29.36	104.30	1.80	0.80	13.10	127.44
179	29.53	213.60	2.10	0.90	6.89	128.62
180	29.69	280.60	2.40	0.80	4.05	130.27
181	29.86	327.80	2.60	0.90	3.02	131.34
182	30.02	355.70	2.80	1.00	2.47	131.82
183	30.19	365.20	2.70	0.90	2.00	131.42
184	30.35	353.80	2.10	0.60	2.28	131.33
185	30.51	320.00	2.80	0.30	3.87	131.77
186	30.68	246.00	3.50	-0.20	6.81	131.22
187	30.84	143.20	2.20	-0.90	10.79	128.74
188	31.01	89.50	1.20	-0.30	15.04	123.29
189	31.17	51.10	0.50	0.10	21.67	118.79
190	31.33	29.50	0.80	0.10	35.56	117.89
191	31.50	24.00	1.30	0.70	40.48	120.93
192	31.66	54.50	1.80	2.00	29.36	124.06

:: Field input data :: (continued)						
Point ID	Depth (ft)	q _c (tsf)	f _s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
193	31.83	95.80	2.00	1.90	18.54	125.94
194	31.99	133.90	1.80	1.40	11.53	126.56
195	32.15	178.70	1.60	0.90	7.46	126.76
196	32.32	214.40	1.70	0.80	5.63	127.46
197	32.48	231.90	2.00	0.60	5.68	129.06
198	32.65	237.10	2.70	0.40	6.50	131.11
199	32.81	259.90	3.60	0.40	7.08	133.11
200	32.97	296.40	4.30	0.40	6.67	133.97
201	33.14	306.10	3.70	0.40	6.02	133.96
202	33.30	301.30	3.40	0.10	5.47	133.45
203	33.47	304.50	3.50	-0.20	5.57	133.35
204	33.63	294.20	3.60	-0.30	6.15	133.55
205	33.79	276.00	3.80	-0.40	7.35	134.22
206	33.96	271.10	4.70	-0.50	8.26	135.13
207	34.12	295.10	5.20	-0.50	7.62	135.00
208	34.29	304.20	3.40	-0.40	7.06	134.84
209	34.45	296.00	4.30	-0.60	7.29	134.46
210	34.61	261.20	4.70	-0.80	9.51	135.18
211	34.78	229.30	5.10	0.00	10.87	135.50
212	34.94	254.50	5.20	0.10	11.12	135.80
213	35.11	266.50	5.30	-0.10	10.24	136.00
214	35.27	277.80	5.20	-0.50	9.51	136.18
215	35.43	299.00	5.30	-0.60	8.69	136.54
216	35.60	331.30	5.70	-0.50	7.97	137.25
217	35.76	365.90	6.30	-0.40	7.43	137.28
218	35.93	390.30	6.70	-0.20	7.27	137.28
219	36.09	391.60	7.00	-0.20	7.40	137.28
220	36.26	375.60	6.90	-0.30	7.73	137.28
221	36.42	352.10	6.40	-0.40	7.89	137.28
222	36.58	320.30	5.20	-0.50	8.04	136.41
223	36.75	270.80	4.10	-0.80	9.88	135.16
224	36.91	189.10	4.80	-1.20	15.01	134.10
225	37.08	103.70	4.70	-1.50	20.74	134.83
226	37.24	174.00	6.50	0.40	15.72	135.64
227	37.40	325.80	5.20	0.80	10.13	137.28
228	37.57	402.30	6.90	0.70	7.47	137.28
229	37.73	451.40	9.00	1.10	7.28	137.28
230	37.90	481.10	9.30	1.10	6.93	137.28
231	38.06	492.20	8.40	1.30	6.40	137.28
232	38.22	479.00	7.90	1.30	6.00	137.28
233	38.39	463.00	7.40	1.10	5.97	137.28
234	38.55	437.10	6.80	1.20	5.98	137.28
235	38.72	418.10	6.30	1.10	6.06	137.28
236	38.88	404.90	6.10	1.10	6.25	137.28
237	39.04	395.40	6.20	1.00	6.06	137.28
238	39.21	391.50	5.10	1.00	6.02	137.28
239	39.37	390.30	5.60	1.00	5.89	137.28
240	39.54	397.60	5.90	1.10	6.00	137.28

:: Field input data :: (continued)

Point ID	Depth (ft)	q _c (tsf)	f _s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
241	39.70	406.00	5.70	1.60	5.84	137.28
242	39.86	420.30	5.90	1.50	5.41	137.28
243	40.03	432.60	5.60	1.50	5.22	137.28
244	40.19	450.50	6.20	1.60	4.78	137.28
245	40.36	472.00	5.80	1.80	4.82	137.28
246	40.52	486.30	6.90	1.80	4.54	137.28
247	40.68	507.60	6.60	1.80	4.92	137.28
248	40.85	499.80	7.60	1.60	4.95	137.28
249	41.01	526.40	7.90	1.80	5.26	137.28
250	41.18	514.50	7.80	1.70	5.12	137.28
251	41.34	504.80	7.20	1.70	4.92	137.28
252	41.50	480.70	6.10	1.20	4.51	137.28
253	41.67	461.00	5.30	1.10	4.15	137.28
254	41.83	416.90	4.30	0.80	3.93	135.64
255	42.00	365.10	3.30	0.40	4.28	133.86
256	42.16	297.50	3.00	0.00	6.14	132.43
257	42.32	197.90	3.10	-1.00	10.56	131.00
258	42.49	108.20	2.60	-1.60	18.40	128.94
259	42.65	67.80	2.00	-1.70	26.63	125.42
260	42.82	54.10	1.00	-1.70	30.95	122.02
261	42.98	47.00	0.90	0.30	33.00	119.10
262	43.15	36.70	0.90	2.10	39.19	118.05
263	43.31	27.30	0.80	49.40	47.51	117.21
264	43.47	23.30	0.80	66.30	52.21	116.24
265	43.64	23.60	0.70	79.00	52.69	116.22
266	43.80	26.00	0.80	89.40	51.53	116.98
267	43.97	27.70	1.00	94.50	49.95	117.40
268	44.13	27.90	0.80	97.90	49.36	117.75
269	44.29	28.60	0.90	96.00	49.11	117.46
270	44.46	27.00	0.90	100.50	51.93	117.61
271	44.62	23.20	0.90	118.80	52.66	117.57
272	44.79	26.90	0.90	125.60	51.91	117.62
273	44.95	28.30	0.90	122.60	49.47	117.77
274	45.11	28.40	0.90	119.00	48.89	117.80
275	45.28	28.40	0.90	120.10	49.22	117.79
276	45.44	27.80	0.90	118.50	48.90	117.50
277	45.61	27.90	0.80	120.60	48.25	116.88
278	45.77	27.20	0.70	122.60	47.50	116.21
279	45.93	26.50	0.70	129.90	47.71	115.82
280	46.10	25.90	0.70	132.70	47.98	115.41
281	46.26	25.10	0.60	133.00	47.44	114.58
282	46.43	24.40	0.50	139.60	46.92	113.65
283	46.59	23.60	0.50	137.50	47.39	113.10
284	46.75	22.30	0.50	148.90	47.52	112.53
285	46.92	22.30	0.40	149.30	46.86	111.97
286	47.08	22.90	0.40	147.90	46.39	111.35
287	47.25	21.30	0.40	147.80	47.64	111.28
288	47.41	20.20	0.40	148.10	48.76	110.51

:: Field input data :: (continued)

Point ID	Depth (ft)	q _c (tsf)	f _s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
289	47.57	19.10	0.30	150.20	49.53	109.69
290	47.74	18.20	0.30	144.60	51.48	109.59
291	47.90	17.50	0.40	145.30	57.91	111.98
292	48.07	17.50	0.70	144.20	68.95	116.52
293	48.23	18.30	1.50	155.70	52.90	122.25
294	48.39	63.30	2.50	169.20	29.65	127.40
295	48.56	156.90	3.20	12.20	21.12	130.71
296	48.72	164.70	4.00	-1.80	17.64	133.06
297	48.89	187.00	5.00	-1.60	18.76	133.74
298	49.05	156.10	4.40	-1.80	18.68	133.29
299	49.22	153.30	3.30	-0.90	16.71	132.36
300	49.38	199.10	3.40	-0.30	10.92	132.15
301	49.54	304.40	3.20	0.30	7.74	132.58

Abbreviations

Depth:	Depth from free surface, at which CPT was performed (ft)
q _c :	Measured cone resistance (tsf)
f _s :	Sleeve friction resistance (tsf)
u:	Pore pressure (tsf)
Fines content:	Percentage of fines in soil (%)
Unit weight:	Bulk soil unit weight (pcf)

:: Cyclic Stress Ratio fully adjusted (CSR*) calculation data ::												
Point ID	Depth (ft)	σ_v (tsf)	u_0 (tsf)	σ'_v (tsf)	r_d	CSR	MSF	CSR_{eq}	K_G	User FS	CSR*	Belongs to transition
1	0.33	0.02	0.00	0.02	1.00	0.826	0.82	1.006	1.00	1.00	2.000	No
2	0.49	0.03	0.00	0.03	1.00	0.826	0.82	1.006	1.00	1.00	2.000	No
3	0.66	0.04	0.00	0.04	1.00	0.826	0.82	1.006	1.00	1.00	2.000	No
4	0.82	0.05	0.00	0.05	1.00	0.825	0.82	1.006	1.00	1.00	2.000	No
5	0.98	0.06	0.00	0.06	1.00	0.825	0.82	1.005	1.00	1.00	2.000	No
6	1.15	0.07	0.00	0.07	1.00	0.825	0.82	1.005	1.00	1.00	2.000	No
7	1.31	0.08	0.00	0.08	1.00	0.825	0.82	1.005	1.00	1.00	2.000	No
8	1.48	0.09	0.00	0.09	1.00	0.824	0.82	1.004	1.00	1.00	2.000	No
9	1.64	0.10	0.00	0.10	1.00	0.824	0.82	1.004	1.00	1.00	2.000	No
10	1.80	0.11	0.00	0.11	1.00	0.824	0.82	1.003	1.00	1.00	2.000	No
11	1.97	0.12	0.00	0.12	1.00	0.823	0.82	1.003	1.00	1.00	2.000	No
12	2.13	0.13	0.00	0.13	1.00	0.823	0.82	1.003	1.00	1.00	2.000	No
13	2.30	0.14	0.00	0.14	1.00	0.823	0.82	1.002	1.00	1.00	2.000	No
14	2.46	0.15	0.00	0.15	1.00	0.822	0.82	1.002	1.00	1.00	2.000	No
15	2.62	0.16	0.00	0.16	1.00	0.822	0.82	1.001	1.00	1.00	2.000	No
16	2.79	0.17	0.00	0.17	1.00	0.822	0.82	1.001	1.00	1.00	2.000	No
17	2.95	0.18	0.00	0.18	1.00	0.821	0.82	1.001	1.00	1.00	2.000	No
18	3.12	0.19	0.00	0.19	0.99	0.821	0.82	1.000	1.00	1.00	2.000	No
19	3.28	0.20	0.00	0.20	0.99	0.821	0.82	1.000	1.00	1.00	2.000	No
20	3.45	0.21	0.00	0.21	0.99	0.820	0.82	0.999	1.00	1.00	2.000	No
21	3.61	0.22	0.00	0.22	0.99	0.820	0.82	0.999	1.00	1.00	2.000	No
22	3.77	0.23	0.00	0.23	0.99	0.820	0.82	0.999	1.00	1.00	2.000	No
23	3.94	0.25	0.00	0.25	0.99	0.819	0.82	0.998	1.00	1.00	2.000	No
24	4.10	0.26	0.00	0.26	0.99	0.819	0.82	0.998	1.00	1.00	2.000	No
25	4.27	0.27	0.00	0.27	0.99	0.819	0.82	0.998	1.00	1.00	2.000	No
26	4.43	0.28	0.00	0.28	0.99	0.819	0.82	0.997	1.00	1.00	2.000	No
27	4.59	0.29	0.00	0.29	0.99	0.818	0.82	0.997	1.00	1.00	2.000	No
28	4.76	0.30	0.00	0.30	0.99	0.818	0.82	0.996	1.00	1.00	2.000	No
29	4.92	0.31	0.00	0.31	0.99	0.818	0.82	0.996	1.00	1.00	2.000	No
30	5.09	0.32	0.00	0.31	0.99	0.825	0.82	1.004	1.00	1.00	1.004	No
31	5.25	0.33	0.01	0.32	0.99	0.837	0.82	1.020	1.00	1.00	1.020	No
32	5.41	0.34	0.01	0.33	0.99	0.849	0.82	1.034	1.00	1.00	1.034	No
33	5.58	0.35	0.02	0.33	0.99	0.861	0.82	1.049	1.00	1.00	1.049	No
34	5.74	0.36	0.02	0.34	0.99	0.872	0.82	1.062	1.00	1.00	1.062	No
35	5.91	0.37	0.03	0.34	0.99	0.883	0.82	1.076	1.00	1.00	1.076	No
36	6.07	0.38	0.03	0.35	0.99	0.894	0.82	1.089	1.00	1.00	1.089	No
37	6.23	0.39	0.04	0.35	0.99	0.904	0.82	1.101	1.00	1.00	2.000	Yes
38	6.40	0.40	0.04	0.36	0.99	0.914	0.82	1.113	1.00	1.00	2.000	Yes
39	6.56	0.41	0.05	0.36	0.99	0.923	0.82	1.125	1.00	1.00	2.000	Yes
40	6.73	0.42	0.05	0.37	0.99	0.933	0.82	1.137	1.00	1.00	2.000	Yes
41	6.89	0.43	0.06	0.37	0.99	0.942	0.82	1.148	1.00	1.00	2.000	Yes
42	7.05	0.44	0.06	0.38	0.99	0.951	0.82	1.159	1.00	1.00	2.000	Yes
43	7.22	0.45	0.07	0.38	0.99	0.960	0.82	1.170	1.00	1.00	2.000	Yes
44	7.38	0.46	0.07	0.39	0.98	0.969	0.82	1.180	1.00	1.00	2.000	Yes
45	7.55	0.47	0.08	0.39	0.98	0.977	0.82	1.191	1.00	1.00	2.000	Yes
46	7.71	0.48	0.08	0.40	0.98	0.985	0.82	1.200	1.00	1.00	1.200	No
47	7.87	0.49	0.09	0.40	0.98	0.993	0.82	1.210	1.00	1.00	1.210	No
48	8.04	0.50	0.09	0.41	0.98	1.001	0.82	1.219	1.00	1.00	1.219	No

:: Cyclic Stress Ratio fully adjusted (CSR*) calculation data :: (continued)												
Point ID	Depth (ft)	σ_v (tsf)	u_0 (tsf)	σ'_v (tsf)	r_d	CSR	MSF	CSR_{eq}	K_G	User FS	CSR*	Belongs to transition
49	8.20	0.51	0.10	0.41	0.98	1.008	0.82	1.228	1.00	1.00	1.228	No
50	8.37	0.52	0.11	0.42	0.98	1.015	0.82	1.237	1.00	1.00	1.237	No
51	8.53	0.53	0.11	0.42	0.98	1.022	0.82	1.245	1.00	1.00	1.245	No
52	8.69	0.54	0.12	0.43	0.98	1.029	0.82	1.253	1.00	1.00	1.253	No
53	8.86	0.55	0.12	0.43	0.98	1.035	0.82	1.261	1.00	1.00	1.261	No
54	9.02	0.56	0.13	0.44	0.98	1.041	0.82	1.268	1.00	1.00	1.268	No
55	9.19	0.58	0.13	0.45	0.98	1.047	0.82	1.276	1.00	1.00	1.276	No
56	9.35	0.59	0.14	0.45	0.98	1.053	0.82	1.283	1.00	1.00	1.283	No
57	9.51	0.60	0.14	0.46	0.98	1.058	0.82	1.289	1.00	1.00	1.289	No
58	9.68	0.61	0.15	0.46	0.98	1.064	0.82	1.296	1.00	1.00	1.296	No
59	9.84	0.62	0.15	0.47	0.98	1.069	0.82	1.303	1.00	1.00	1.303	No
60	10.01	0.63	0.16	0.47	0.98	1.075	0.82	1.309	1.00	1.00	1.309	No
61	10.17	0.64	0.16	0.48	0.98	1.079	0.82	1.315	1.00	1.00	1.315	No
62	10.34	0.65	0.17	0.49	0.98	1.085	0.82	1.321	1.00	1.00	1.321	No
63	10.50	0.66	0.17	0.49	0.98	1.089	0.82	1.327	1.00	1.00	1.327	No
64	10.66	0.67	0.18	0.50	0.98	1.094	0.82	1.333	1.00	1.00	1.333	No
65	10.83	0.68	0.18	0.50	0.98	1.099	0.82	1.338	1.00	1.00	1.338	No
66	10.99	0.69	0.19	0.51	0.98	1.103	0.82	1.344	1.00	1.00	1.344	No
67	11.16	0.71	0.19	0.51	0.98	1.108	0.82	1.350	1.00	1.00	1.350	No
68	11.32	0.72	0.20	0.52	0.98	1.112	0.82	1.355	1.00	1.00	1.355	No
69	11.48	0.73	0.20	0.52	0.98	1.117	0.82	1.360	1.00	1.00	1.360	No
70	11.65	0.74	0.21	0.53	0.98	1.121	0.82	1.366	1.00	1.00	1.366	No
71	11.81	0.75	0.21	0.53	0.98	1.126	0.82	1.371	1.00	1.00	1.371	No
72	11.98	0.76	0.22	0.54	0.97	1.130	0.82	1.377	1.00	1.00	1.377	No
73	12.14	0.77	0.22	0.54	0.97	1.134	0.82	1.382	1.00	1.00	1.382	No
74	12.30	0.78	0.23	0.55	0.97	1.138	0.82	1.386	1.00	1.00	1.386	No
75	12.47	0.79	0.23	0.55	0.97	1.142	0.82	1.391	1.00	1.00	1.391	No
76	12.63	0.80	0.24	0.56	0.97	1.146	0.82	1.396	1.00	1.00	1.396	No
77	12.80	0.81	0.24	0.56	0.97	1.150	0.82	1.400	1.00	1.00	1.400	No
78	12.96	0.82	0.25	0.57	0.97	1.153	0.82	1.405	1.00	1.00	1.405	No
79	13.12	0.83	0.25	0.58	0.97	1.156	0.82	1.409	1.00	1.00	1.409	No
80	13.29	0.84	0.26	0.58	0.97	1.160	0.82	1.413	1.00	1.00	1.413	No
81	13.45	0.85	0.26	0.59	0.97	1.163	0.82	1.417	1.00	1.00	1.417	No
82	13.62	0.86	0.27	0.59	0.97	1.167	0.82	1.421	1.00	1.00	1.421	No
83	13.78	0.87	0.27	0.60	0.97	1.170	0.82	1.425	1.00	1.00	1.425	No
84	13.94	0.88	0.28	0.60	0.97	1.173	0.82	1.429	1.00	1.00	1.429	No
85	14.11	0.89	0.28	0.61	0.97	1.176	0.82	1.433	1.00	1.00	1.433	No
86	14.27	0.90	0.29	0.61	0.97	1.179	0.82	1.436	1.00	1.00	1.436	No
87	14.44	0.91	0.29	0.62	0.97	1.182	0.82	1.440	1.00	1.00	2.000	Yes
88	14.60	0.92	0.30	0.62	0.97	1.185	0.82	1.443	1.00	1.00	2.000	Yes
89	14.76	0.93	0.30	0.63	0.97	1.187	0.82	1.446	1.00	1.00	2.000	Yes
90	14.93	0.94	0.31	0.63	0.97	1.190	0.82	1.450	1.00	1.00	2.000	Yes
91	15.09	0.95	0.31	0.64	0.97	1.193	0.82	1.453	1.00	1.00	2.000	Yes
92	15.26	0.96	0.32	0.64	0.97	1.196	0.82	1.457	1.00	1.00	2.000	Yes
93	15.42	0.97	0.33	0.65	0.97	1.199	0.82	1.460	1.00	1.00	2.000	Yes
94	15.58	0.98	0.33	0.65	0.97	1.201	0.82	1.464	1.00	1.00	2.000	Yes
95	15.75	0.99	0.34	0.66	0.97	1.204	0.82	1.467	1.00	1.00	1.467	No
96	15.91	1.01	0.34	0.66	0.97	1.207	0.82	1.470	1.00	1.00	1.470	No

:: Cyclic Stress Ratio fully adjusted (CSR*) calculation data :: (continued)												
Point ID	Depth (ft)	σ_v (tsf)	u_0 (tsf)	σ'_v (tsf)	r_d	CSR	MSF	CSR_{eq}	K_G	User FS	CSR*	Belongs to transition
97	16.08	1.02	0.35	0.67	0.97	1.209	0.82	1.473	1.00	1.00	1.473	No
98	16.24	1.03	0.35	0.68	0.97	1.211	0.82	1.475	1.00	1.00	1.475	No
99	16.40	1.04	0.36	0.68	0.97	1.213	0.82	1.478	1.00	1.00	1.478	No
100	16.57	1.05	0.36	0.69	0.97	1.215	0.82	1.481	1.00	1.00	1.481	No
101	16.73	1.06	0.37	0.69	0.96	1.217	0.82	1.483	1.00	1.00	1.483	No
102	16.90	1.07	0.37	0.70	0.96	1.219	0.82	1.485	1.00	1.00	1.485	No
103	17.06	1.08	0.38	0.70	0.96	1.221	0.82	1.487	1.00	1.00	1.487	No
104	17.23	1.09	0.38	0.71	0.96	1.223	0.82	1.490	1.00	1.00	1.490	No
105	17.39	1.10	0.39	0.72	0.96	1.225	0.82	1.492	1.00	1.00	1.492	No
106	17.55	1.11	0.39	0.72	0.96	1.226	0.82	1.494	1.00	1.00	1.494	No
107	17.72	1.12	0.40	0.73	0.96	1.228	0.82	1.496	1.00	1.00	1.496	No
108	17.88	1.13	0.40	0.73	0.96	1.230	0.82	1.498	1.00	1.00	1.498	No
109	18.05	1.15	0.41	0.74	0.96	1.231	0.82	1.500	1.00	1.00	1.500	No
110	18.21	1.16	0.41	0.74	0.96	1.233	0.82	1.502	1.00	1.00	1.502	No
111	18.37	1.17	0.42	0.75	0.96	1.234	0.82	1.503	1.00	1.00	1.503	No
112	18.54	1.18	0.42	0.76	0.96	1.236	0.82	1.505	1.00	1.00	1.505	No
113	18.70	1.19	0.43	0.76	0.96	1.237	0.82	1.507	1.00	1.00	1.507	No
114	18.87	1.20	0.43	0.77	0.96	1.238	0.82	1.509	1.00	1.00	1.509	No
115	19.03	1.21	0.44	0.77	0.96	1.240	0.82	1.510	1.00	1.00	1.510	No
116	19.19	1.22	0.44	0.78	0.96	1.241	0.82	1.512	1.00	1.00	1.512	No
117	19.36	1.23	0.45	0.79	0.96	1.243	0.82	1.514	1.00	1.00	1.514	No
118	19.52	1.24	0.45	0.79	0.96	1.244	0.82	1.516	1.00	1.00	1.516	No
119	19.69	1.25	0.46	0.80	0.96	1.246	0.82	1.518	1.00	1.00	1.518	No
120	19.85	1.26	0.46	0.80	0.96	1.247	0.82	1.520	1.00	1.00	1.520	No
121	20.01	1.27	0.47	0.81	0.96	1.249	0.82	1.521	1.00	1.00	1.521	No
122	20.18	1.28	0.47	0.81	0.96	1.251	0.82	1.523	1.00	1.00	1.523	No
123	20.34	1.29	0.48	0.82	0.96	1.252	0.82	1.525	1.00	1.00	1.525	No
124	20.51	1.31	0.48	0.82	0.96	1.253	0.82	1.527	1.00	1.00	1.527	No
125	20.67	1.32	0.49	0.83	0.96	1.255	0.82	1.528	1.00	1.00	1.528	No
126	20.83	1.33	0.49	0.83	0.95	1.256	0.82	1.530	1.00	1.00	1.530	No
127	21.00	1.34	0.50	0.84	0.95	1.257	0.82	1.531	1.00	1.00	1.531	No
128	21.16	1.35	0.50	0.84	0.95	1.258	0.82	1.533	1.00	1.00	1.533	No
129	21.33	1.36	0.51	0.85	0.95	1.259	0.82	1.534	1.00	1.00	1.534	No
130	21.49	1.37	0.51	0.85	0.95	1.260	0.82	1.535	1.00	1.00	1.535	No
131	21.65	1.38	0.52	0.86	0.95	1.261	0.82	1.536	1.00	1.00	1.536	No
132	21.82	1.39	0.52	0.87	0.95	1.262	0.82	1.538	1.00	1.00	1.538	No
133	21.98	1.40	0.53	0.87	0.95	1.263	0.82	1.539	1.00	1.00	1.539	No
134	22.15	1.41	0.54	0.88	0.95	1.264	0.82	1.540	1.00	1.00	1.540	No
135	22.31	1.42	0.54	0.88	0.95	1.264	0.82	1.540	1.00	1.00	1.540	No
136	22.47	1.43	0.55	0.89	0.95	1.265	0.82	1.541	1.00	1.00	1.541	No
137	22.64	1.45	0.55	0.90	0.95	1.266	0.82	1.542	1.00	1.00	1.542	No
138	22.80	1.46	0.56	0.90	0.95	1.266	0.82	1.543	1.00	1.00	1.543	No
139	22.97	1.47	0.56	0.91	0.95	1.267	0.82	1.544	1.00	1.00	1.544	No
140	23.13	1.48	0.57	0.91	0.95	1.268	0.82	1.544	1.00	1.00	1.544	No
141	23.30	1.49	0.57	0.92	0.95	1.268	0.82	1.545	1.00	1.00	1.545	No
142	23.46	1.50	0.58	0.92	0.95	1.269	0.82	1.546	1.00	1.00	1.546	No
143	23.62	1.51	0.58	0.93	0.95	1.269	0.82	1.546	1.00	1.00	1.546	No
144	23.79	1.52	0.59	0.94	0.95	1.270	0.82	1.547	1.00	1.00	1.547	No

:: Cyclic Stress Ratio fully adjusted (CSR*) calculation data :: (continued)

Point ID	Depth (ft)	σ_v (tsf)	u_0 (tsf)	σ'_v (tsf)	r_d	CSR	MSF	CSR_{eq}	K_G	User FS	CSR*	Belongs to transition
145	23.95	1.53	0.59	0.94	0.95	1.270	0.82	1.548	1.00	1.00	1.548	No
146	24.12	1.54	0.60	0.95	0.94	1.271	0.82	1.548	1.00	1.00	1.548	No
147	24.28	1.55	0.60	0.95	0.94	1.271	0.82	1.549	1.00	1.00	1.549	No
148	24.44	1.57	0.61	0.96	0.94	1.272	0.82	1.549	1.00	1.00	1.549	No
149	24.61	1.58	0.61	0.96	0.94	1.272	0.82	1.550	1.00	1.00	1.550	No
150	24.77	1.59	0.62	0.97	0.94	1.273	0.82	1.550	1.00	1.00	1.550	No
151	24.94	1.60	0.62	0.98	0.94	1.273	0.82	1.551	1.00	1.00	1.551	No
152	25.10	1.61	0.63	0.98	0.94	1.274	0.82	1.552	1.00	1.00	1.552	No
153	25.26	1.62	0.63	0.99	0.94	1.274	0.82	1.552	1.00	1.00	1.552	No
154	25.43	1.63	0.64	0.99	0.94	1.275	0.82	1.553	1.00	1.00	1.553	No
155	25.59	1.64	0.64	1.00	0.94	1.276	0.82	1.554	1.00	1.00	1.554	No
156	25.76	1.65	0.65	1.00	0.94	1.276	0.82	1.555	1.00	1.00	1.555	No
157	25.92	1.66	0.65	1.01	0.94	1.277	0.82	1.556	1.00	1.00	1.556	No
158	26.08	1.67	0.66	1.01	0.94	1.278	0.82	1.556	1.00	1.00	1.556	No
159	26.25	1.68	0.66	1.02	0.94	1.278	0.82	1.557	1.00	1.00	1.557	No
160	26.41	1.69	0.67	1.02	0.94	1.278	0.82	1.557	1.00	1.00	1.557	No
161	26.58	1.70	0.67	1.03	0.94	1.278	0.82	1.557	1.00	1.00	1.557	No
162	26.74	1.71	0.68	1.03	0.94	1.278	0.82	1.557	1.00	1.00	1.557	No
163	26.90	1.72	0.68	1.04	0.93	1.278	0.82	1.557	1.00	1.00	1.557	No
164	27.07	1.74	0.69	1.05	0.93	1.278	0.82	1.557	1.00	1.00	1.557	No
165	27.23	1.75	0.69	1.05	0.93	1.278	0.82	1.557	1.00	1.00	1.557	No
166	27.40	1.76	0.70	1.06	0.93	1.278	0.82	1.557	1.00	1.00	1.557	No
167	27.56	1.77	0.70	1.06	0.93	1.279	0.82	1.558	1.00	1.00	1.558	No
168	27.72	1.78	0.71	1.07	0.93	1.279	0.82	1.558	1.00	1.00	1.558	No
169	27.89	1.79	0.71	1.07	0.93	1.280	0.82	1.559	1.00	1.00	1.559	No
170	28.05	1.80	0.72	1.08	0.93	1.280	0.82	1.559	1.00	1.00	1.559	No
171	28.22	1.81	0.72	1.08	0.93	1.280	0.82	1.559	1.00	1.00	1.559	No
172	28.38	1.82	0.73	1.09	0.93	1.280	0.82	1.559	1.00	1.00	1.559	No
173	28.54	1.83	0.73	1.09	0.93	1.280	0.82	1.559	1.00	1.00	1.559	No
174	28.71	1.84	0.74	1.10	0.93	1.280	0.82	1.559	1.00	1.00	1.559	No
175	28.87	1.85	0.74	1.10	0.93	1.280	0.82	1.559	1.00	1.00	1.559	No
176	29.04	1.86	0.75	1.11	0.93	1.280	0.82	1.559	1.00	1.00	1.559	No
177	29.20	1.87	0.76	1.12	0.92	1.280	0.82	1.559	1.00	1.00	1.559	No
178	29.36	1.88	0.76	1.12	0.92	1.280	0.82	1.559	1.00	1.00	1.559	No
179	29.53	1.89	0.77	1.13	0.92	1.280	0.82	1.559	1.00	1.00	1.559	No
180	29.69	1.90	0.77	1.13	0.92	1.280	0.82	1.559	1.00	1.00	1.559	No
181	29.86	1.91	0.78	1.14	0.92	1.279	0.82	1.558	1.00	1.00	1.558	No
182	30.02	1.92	0.78	1.14	0.92	1.279	0.82	1.558	1.00	1.00	1.558	No
183	30.19	1.93	0.79	1.15	0.92	1.279	0.82	1.558	1.00	1.00	1.558	No
184	30.35	1.95	0.79	1.15	0.92	1.278	0.82	1.557	1.00	1.00	1.557	No
185	30.51	1.96	0.80	1.16	0.92	1.278	0.82	1.557	1.00	1.00	1.557	No
186	30.68	1.97	0.80	1.17	0.92	1.277	0.82	1.556	1.00	1.00	2.000	Yes
187	30.84	1.98	0.81	1.17	0.92	1.277	0.82	1.556	1.00	1.00	2.000	Yes
188	31.01	1.99	0.81	1.18	0.92	1.277	0.82	1.556	1.00	1.00	2.000	Yes
189	31.17	2.00	0.82	1.18	0.91	1.277	0.82	1.556	1.00	1.00	2.000	Yes
190	31.33	2.01	0.82	1.18	0.91	1.277	0.82	1.556	1.00	1.00	2.000	Yes
191	31.50	2.02	0.83	1.19	0.91	1.277	0.82	1.555	1.00	1.00	2.000	Yes
192	31.66	2.03	0.83	1.19	0.91	1.276	0.82	1.555	1.00	1.00	2.000	Yes

:: Cyclic Stress Ratio fully adjusted (CSR*) calculation data :: (continued)												
Point ID	Depth (ft)	σ_v (tsf)	u_0 (tsf)	σ'_v (tsf)	r_d	CSR	MSF	CSR_{eq}	K_G	User FS	CSR*	Belongs to transition
193	31.83	2.04	0.84	1.20	0.91	1.276	0.82	1.555	1.00	1.00	2.000	Yes
194	31.99	2.05	0.84	1.21	0.91	1.276	0.82	1.554	1.00	1.00	2.000	Yes
195	32.15	2.06	0.85	1.21	0.91	1.275	0.82	1.554	1.00	1.00	2.000	Yes
196	32.32	2.07	0.85	1.22	0.91	1.275	0.82	1.553	1.00	1.00	1.553	No
197	32.48	2.08	0.86	1.22	0.91	1.274	0.82	1.552	1.00	1.00	1.552	No
198	32.65	2.09	0.86	1.23	0.91	1.273	0.82	1.551	1.00	1.00	1.551	No
199	32.81	2.10	0.87	1.23	0.90	1.273	0.82	1.550	1.00	1.00	1.550	No
200	32.97	2.11	0.87	1.24	0.90	1.272	0.82	1.549	1.00	1.00	1.549	No
201	33.14	2.12	0.88	1.24	0.90	1.271	0.82	1.548	1.00	1.00	1.548	No
202	33.30	2.13	0.88	1.25	0.90	1.270	0.82	1.547	1.00	1.00	1.547	No
203	33.47	2.14	0.89	1.26	0.90	1.269	0.82	1.546	1.00	1.00	1.546	No
204	33.63	2.16	0.89	1.26	0.90	1.268	0.82	1.545	1.00	1.00	1.545	No
205	33.79	2.17	0.90	1.27	0.90	1.268	0.82	1.544	1.00	1.00	1.544	No
206	33.96	2.18	0.90	1.27	0.90	1.267	0.82	1.543	1.00	1.00	1.543	No
207	34.12	2.19	0.91	1.28	0.90	1.266	0.82	1.542	1.00	1.00	1.542	No
208	34.29	2.20	0.91	1.29	0.90	1.264	0.82	1.540	1.00	1.00	1.540	No
209	34.45	2.21	0.92	1.29	0.89	1.263	0.82	1.539	1.00	1.00	1.539	No
210	34.61	2.22	0.92	1.30	0.89	1.262	0.82	1.538	1.00	1.00	1.538	No
211	34.78	2.23	0.93	1.30	0.89	1.261	0.82	1.536	1.00	1.00	1.536	No
212	34.94	2.24	0.93	1.31	0.89	1.260	0.82	1.535	1.00	1.00	1.535	No
213	35.11	2.26	0.94	1.32	0.89	1.259	0.82	1.534	1.00	1.00	1.534	No
214	35.27	2.27	0.94	1.32	0.89	1.258	0.82	1.532	1.00	1.00	1.532	No
215	35.43	2.28	0.95	1.33	0.89	1.257	0.82	1.531	1.00	1.00	1.531	No
216	35.60	2.29	0.95	1.33	0.89	1.255	0.82	1.529	1.00	1.00	1.529	No
217	35.76	2.30	0.96	1.34	0.89	1.254	0.82	1.528	1.00	1.00	1.528	No
218	35.93	2.31	0.97	1.35	0.88	1.253	0.82	1.526	1.00	1.00	1.526	No
219	36.09	2.32	0.97	1.35	0.88	1.251	0.82	1.524	1.00	1.00	1.524	No
220	36.26	2.33	0.98	1.36	0.88	1.250	0.82	1.523	1.00	1.00	1.523	No
221	36.42	2.35	0.98	1.36	0.88	1.249	0.82	1.521	1.00	1.00	1.521	No
222	36.58	2.36	0.99	1.37	0.88	1.247	0.82	1.520	1.00	1.00	1.520	No
223	36.75	2.37	0.99	1.38	0.88	1.246	0.82	1.518	1.00	1.00	1.518	No
224	36.91	2.38	1.00	1.38	0.88	1.245	0.82	1.516	1.00	1.00	1.516	No
225	37.08	2.39	1.00	1.39	0.88	1.243	0.82	1.515	1.00	1.00	1.515	No
226	37.24	2.40	1.01	1.39	0.87	1.242	0.82	1.513	1.00	1.00	1.513	No
227	37.40	2.41	1.01	1.40	0.87	1.240	0.82	1.511	1.00	1.00	1.511	No
228	37.57	2.42	1.02	1.41	0.87	1.239	0.82	1.509	1.00	1.00	1.509	No
229	37.73	2.43	1.02	1.41	0.87	1.237	0.82	1.507	1.00	1.00	1.507	No
230	37.90	2.45	1.03	1.42	0.87	1.236	0.82	1.505	1.00	1.00	1.505	No
231	38.06	2.46	1.03	1.43	0.87	1.234	0.82	1.504	1.00	1.00	1.504	No
232	38.22	2.47	1.04	1.43	0.87	1.233	0.82	1.502	1.00	1.00	1.502	No
233	38.39	2.48	1.04	1.44	0.86	1.231	0.82	1.500	1.00	1.00	1.500	No
234	38.55	2.49	1.05	1.44	0.86	1.230	0.82	1.498	1.00	1.00	1.498	No
235	38.72	2.50	1.05	1.45	0.86	1.228	0.82	1.496	1.00	1.00	1.496	No
236	38.88	2.51	1.06	1.46	0.86	1.226	0.82	1.494	1.00	1.00	1.494	No
237	39.04	2.52	1.06	1.46	0.86	1.225	0.82	1.492	1.00	1.00	1.492	No
238	39.21	2.54	1.07	1.47	0.86	1.223	0.82	1.490	1.00	1.00	1.490	No
239	39.37	2.55	1.07	1.47	0.86	1.221	0.82	1.488	1.00	1.00	1.488	No
240	39.54	2.56	1.08	1.48	0.86	1.220	0.82	1.486	1.00	1.00	1.486	No

:: Cyclic Stress Ratio fully adjusted (CSR*) calculation data :: (continued)												
Point ID	Depth (ft)	σ_v (tsf)	u_0 (tsf)	σ'_v (tsf)	r_d	CSR	MSF	CSR_{eq}	K_G	User FS	CSR*	Belongs to transition
241	39.70	2.57	1.08	1.49	0.85	1.218	0.82	1.484	1.00	1.00	1.484	No
242	39.86	2.58	1.09	1.49	0.85	1.216	0.82	1.481	1.00	1.00	1.481	No
243	40.03	2.59	1.09	1.50	0.85	1.214	0.82	1.479	1.00	1.00	1.479	No
244	40.19	2.60	1.10	1.51	0.85	1.213	0.82	1.477	1.00	1.00	1.477	No
245	40.36	2.61	1.10	1.51	0.85	1.211	0.82	1.475	1.00	1.00	1.475	No
246	40.52	2.63	1.11	1.52	0.85	1.209	0.82	1.473	1.00	1.00	1.473	No
247	40.68	2.64	1.11	1.52	0.84	1.207	0.82	1.471	1.00	1.00	1.471	No
248	40.85	2.65	1.12	1.53	0.84	1.205	0.82	1.468	1.00	1.00	1.468	No
249	41.01	2.66	1.12	1.54	0.84	1.203	0.82	1.466	1.00	1.00	1.466	No
250	41.18	2.67	1.13	1.54	0.84	1.202	0.82	1.464	1.00	1.00	1.464	No
251	41.34	2.68	1.13	1.55	0.84	1.200	0.82	1.462	1.00	1.00	1.462	No
252	41.50	2.69	1.14	1.55	0.84	1.198	0.82	1.459	1.00	1.00	1.459	No
253	41.67	2.70	1.14	1.56	0.84	1.196	0.82	1.457	1.00	1.00	1.457	No
254	41.83	2.72	1.15	1.57	0.83	1.194	0.82	1.455	1.00	1.00	1.455	No
255	42.00	2.73	1.15	1.57	0.83	1.192	0.82	1.452	1.00	1.00	1.452	No
256	42.16	2.74	1.16	1.58	0.83	1.190	0.82	1.450	1.00	1.00	2.000	Yes
257	42.32	2.75	1.16	1.58	0.83	1.189	0.82	1.448	1.00	1.00	2.000	Yes
258	42.49	2.76	1.17	1.59	0.83	1.187	0.82	1.446	1.00	1.00	2.000	Yes
259	42.65	2.77	1.17	1.59	0.83	1.185	0.82	1.444	1.00	1.00	2.000	Yes
260	42.82	2.78	1.18	1.60	0.83	1.184	0.82	1.442	1.00	1.00	2.000	Yes
261	42.98	2.79	1.18	1.60	0.82	1.182	0.82	1.440	1.00	1.00	1.440	No
262	43.15	2.80	1.19	1.61	0.82	1.180	0.82	1.438	1.00	1.00	1.438	No
263	43.31	2.81	1.20	1.61	0.82	1.179	0.82	1.436	1.00	1.00	1.436	No
264	43.47	2.82	1.20	1.62	0.82	1.177	0.82	1.434	1.00	1.00	1.434	No
265	43.64	2.83	1.21	1.62	0.82	1.176	0.82	1.432	1.00	1.00	1.432	No
266	43.80	2.84	1.21	1.63	0.82	1.174	0.82	1.431	1.00	1.00	1.431	No
267	43.97	2.85	1.22	1.63	0.81	1.173	0.82	1.429	1.00	1.00	1.429	No
268	44.13	2.86	1.22	1.64	0.81	1.171	0.82	1.427	1.00	1.00	1.427	No
269	44.29	2.87	1.23	1.64	0.81	1.170	0.82	1.425	1.00	1.00	1.425	No
270	44.46	2.88	1.23	1.64	0.81	1.168	0.82	1.423	1.00	1.00	1.423	No
271	44.62	2.89	1.24	1.65	0.81	1.166	0.82	1.421	1.00	1.00	1.421	No
272	44.79	2.90	1.24	1.65	0.81	1.164	0.82	1.419	1.00	1.00	1.419	No
273	44.95	2.90	1.25	1.66	0.80	1.163	0.82	1.417	1.00	1.00	1.417	No
274	45.11	2.91	1.25	1.66	0.80	1.161	0.82	1.415	1.00	1.00	1.415	No
275	45.28	2.92	1.26	1.67	0.80	1.159	0.82	1.412	1.00	1.00	1.412	No
276	45.44	2.93	1.26	1.67	0.80	1.158	0.82	1.410	1.00	1.00	1.410	No
277	45.61	2.94	1.27	1.68	0.80	1.156	0.82	1.408	1.00	1.00	1.408	No
278	45.77	2.95	1.27	1.68	0.80	1.154	0.82	1.406	1.00	1.00	1.406	No
279	45.93	2.96	1.28	1.68	0.79	1.153	0.82	1.404	1.00	1.00	1.404	No
280	46.10	2.97	1.28	1.69	0.79	1.151	0.82	1.402	1.00	1.00	1.402	No
281	46.26	2.98	1.29	1.69	0.79	1.149	0.82	1.400	1.00	1.00	1.400	No
282	46.43	2.99	1.29	1.70	0.79	1.147	0.82	1.398	1.00	1.00	1.398	No
283	46.59	3.00	1.30	1.70	0.79	1.146	0.82	1.396	1.00	1.00	1.396	No
284	46.75	3.01	1.30	1.71	0.79	1.144	0.82	1.394	1.00	1.00	1.394	No
285	46.92	3.02	1.31	1.71	0.78	1.142	0.82	1.392	1.00	1.00	1.392	No
286	47.08	3.03	1.31	1.71	0.78	1.141	0.82	1.390	1.00	1.00	1.390	No
287	47.25	3.04	1.32	1.72	0.78	1.139	0.82	1.388	1.00	1.00	1.388	No
288	47.41	3.05	1.32	1.72	0.78	1.137	0.82	1.386	1.00	1.00	1.386	No

:: Cyclic Stress Ratio fully adjusted (CSR*) calculation data :: (continued)

Point ID	Depth (ft)	σ_v (tsf)	u_0 (tsf)	σ_v' (tsf)	r_d	CSR	MSF	CSR_{eq}	K_σ	User FS	CSR*	Belongs to transition
289	47.57	3.05	1.33	1.73	0.78	1.136	0.82	1.384	1.00	1.00	1.384	No
290	47.74	3.06	1.33	1.73	0.78	1.134	0.82	1.382	1.00	1.00	1.382	No
291	47.90	3.07	1.34	1.73	0.77	1.132	0.82	1.380	1.00	1.00	1.380	No
292	48.07	3.08	1.34	1.74	0.77	1.131	0.82	1.377	1.00	1.00	1.377	No
293	48.23	3.09	1.35	1.74	0.77	1.129	0.82	1.375	1.00	1.00	2.000	Yes
294	48.39	3.10	1.35	1.75	0.77	1.127	0.82	1.372	1.00	1.00	2.000	Yes
295	48.56	3.11	1.36	1.75	0.77	1.124	0.82	1.370	1.00	1.00	2.000	Yes
296	48.72	3.12	1.36	1.76	0.77	1.122	0.82	1.367	1.00	1.00	2.000	Yes
297	48.89	3.14	1.37	1.77	0.76	1.120	0.82	1.364	1.00	1.00	1.364	No
298	49.05	3.15	1.37	1.77	0.76	1.118	0.82	1.362	1.00	1.00	1.362	No
299	49.22	3.16	1.38	1.78	0.76	1.115	0.82	1.359	1.00	1.00	1.359	No
300	49.38	3.17	1.38	1.78	0.76	1.113	0.82	1.356	1.00	1.00	1.356	No
301	49.54	3.18	1.39	1.79	0.76	1.111	0.82	1.353	1.00	1.00	1.353	No

Abbreviations

Depth:	Depth from free surface, at which CPT was performed (ft)
σ_v :	Total overburden pressure at test point (tsf)
u_0 :	Water pressure at test point (tsf)
σ_v' :	Effective overburden pressure based on GWT during earthquake (tsf)
r_d :	Nonlinear shear mass factor
CSR:	Cyclic Stress Ratio
MSF:	Magnitude Scaling Factor
CSR_{eq} :	CSR adjusted for M=7.5
K_σ :	Effective overburden stress factor
CSR*:	CSR fully adjusted

:: Cyclic Resistance Ratio (CRR) calculation data ::												
Point ID	Depth (ft)	q_t (tsf)	I_c	Fr (%)	n	Q_{tn}	K_c	$Q_{tn,cs}$	CRR _{7.5}	Belongs to trans. layer	Clay-like behaviour	FS
1	0.33	181.37	1.43	0.72	0.39	342.77	1.00	342.77	4.000	No	No	2.00
2	0.49	197.20	1.45	0.83	0.40	372.68	1.00	372.68	4.000	No	No	2.00
3	0.66	206.87	1.48	0.93	0.42	390.93	1.00	390.93	4.000	No	No	2.00
4	0.82	194.07	1.54	1.05	0.44	366.72	1.00	366.72	4.000	No	No	2.00
5	0.98	169.30	1.58	1.06	0.45	319.89	1.00	319.89	4.000	No	No	2.00
6	1.15	149.80	1.60	1.02	0.46	283.01	1.00	283.01	4.000	No	No	2.00
7	1.31	138.40	1.57	0.89	0.45	261.44	1.00	261.44	4.000	No	No	2.00
8	1.48	132.53	1.58	0.88	0.46	250.33	1.00	250.33	4.000	No	No	2.00
9	1.64	126.23	1.67	1.11	0.49	238.41	1.02	242.85	4.000	No	No	2.00
10	1.80	122.80	1.75	1.39	0.52	231.90	1.07	249.04	4.000	No	No	2.00
11	1.97	116.20	1.79	1.46	0.54	219.40	1.10	240.79	4.000	No	No	2.00
12	2.13	104.53	1.77	1.28	0.53	197.33	1.09	214.41	4.000	No	No	2.00
13	2.30	91.43	1.73	0.99	0.52	172.55	1.06	182.60	4.000	No	No	2.00
14	2.46	83.56	1.74	0.92	0.52	157.66	1.06	167.62	4.000	No	No	2.00
15	2.62	88.73	1.71	0.90	0.51	167.41	1.05	175.25	4.000	No	No	2.00
16	2.79	105.33	1.65	0.89	0.49	198.77	1.01	200.07	4.000	No	No	2.00
17	2.95	128.13	1.59	0.86	0.46	241.85	1.00	241.85	4.000	No	No	2.00
18	3.12	152.93	1.52	0.83	0.44	288.70	1.00	288.70	4.000	No	No	2.00
19	3.28	173.37	1.47	0.79	0.42	326.78	1.00	326.78	4.000	No	No	2.00
20	3.45	189.27	1.44	0.76	0.41	344.05	1.00	344.05	4.000	No	No	2.00
21	3.61	191.90	1.44	0.75	0.41	342.18	1.00	342.18	4.000	No	No	2.00
22	3.77	183.90	1.46	0.76	0.42	326.04	1.00	326.04	4.000	No	No	2.00
23	3.94	170.27	1.48	0.76	0.43	300.60	1.00	300.60	4.000	No	No	2.00
24	4.10	161.03	1.50	0.77	0.44	282.61	1.00	282.61	4.000	No	No	2.00
25	4.27	157.63	1.51	0.76	0.44	272.54	1.00	272.54	4.000	No	No	2.00
26	4.43	157.23	1.52	0.76	0.44	268.40	1.00	268.40	4.000	No	No	2.00
27	4.59	154.93	1.56	0.86	0.46	265.92	1.00	265.92	4.000	No	No	2.00
28	4.76	152.33	1.61	0.99	0.48	263.18	1.00	263.18	4.000	No	No	2.00
29	4.92	151.03	1.66	1.15	0.50	263.58	1.01	265.50	4.000	No	No	2.00
30	5.09	171.13	1.62	1.11	0.48	289.55	1.00	289.55	4.000	No	No	2.00
31	5.25	207.52	1.55	1.03	0.46	337.89	1.00	337.89	4.000	No	No	2.00
32	5.41	255.05	1.49	0.97	0.43	400.40	1.00	400.40	4.000	No	No	2.00
33	5.58	290.49	1.45	0.94	0.42	445.48	1.00	445.48	4.000	No	No	2.00
34	5.74	311.59	1.43	0.93	0.41	471.07	1.00	471.07	4.000	No	No	2.00
35	5.91	293.20	1.47	1.00	0.43	447.53	1.00	447.53	4.000	No	No	2.00
36	6.07	238.46	1.58	1.23	0.47	379.49	1.00	379.49	4.000	No	No	2.00
37	6.23	155.92	1.80	1.78	0.55	269.72	1.11	298.55	4.000	Yes	No	2.00
38	6.40	91.94	2.05	2.62	0.65	173.02	1.37	237.23	4.000	Yes	No	2.00
39	6.56	54.08	2.32	3.85	0.75	101.43	2.03	205.87	4.000	Yes	No	2.00
40	6.73	40.21	2.45	4.44	0.80	75.21	2.55	191.87	4.000	Yes	No	2.00
41	6.89	37.72	2.44	4.02	0.80	70.48	2.49	175.40	4.000	Yes	No	2.00
42	7.05	43.89	2.26	2.61	0.73	82.12	1.82	149.49	4.000	Yes	No	2.00
43	7.22	56.78	2.02	1.48	0.64	101.71	1.32	134.66	4.000	Yes	No	2.00
44	7.38	71.21	1.85	0.99	0.57	118.84	1.15	136.10	4.000	Yes	No	2.00
45	7.55	84.15	1.76	0.84	0.54	134.96	1.08	145.62	4.000	Yes	No	2.00
46	7.71	96.93	1.73	0.86	0.53	152.80	1.06	161.62	0.473	No	No	0.39
47	7.87	112.03	1.70	0.90	0.52	173.72	1.04	180.24	0.625	No	No	0.52
48	8.04	130.16	1.67	0.93	0.50	198.38	1.02	201.55	4.000	No	No	2.00

:: Cyclic Resistance Ratio (CRR) calculation data :: (continued)												
Point ID	Depth (ft)	q _t (tsf)	I _c	Fr (%)	n	Q _{tn}	K _c	Q _{tn,cs}	CRR _{7.5}	Belongs to trans. layer	Clay-like behaviour	FS
49	8.20	153.27	1.59	0.83	0.48	226.24	1.00	226.24	4.000	No	No	2.00
50	8.37	181.77	1.54	0.81	0.46	262.00	1.00	262.00	4.000	No	No	2.00
51	8.53	216.44	1.51	0.83	0.44	306.54	1.00	306.54	4.000	No	No	2.00
52	8.69	248.21	1.51	0.93	0.44	349.75	1.00	349.75	4.000	No	No	2.00
53	8.86	271.31	1.51	1.00	0.45	380.51	1.00	380.51	4.000	No	No	2.00
54	9.02	288.21	1.50	1.01	0.44	400.81	1.00	400.81	4.000	No	No	2.00
55	9.19	309.21	1.48	0.98	0.43	424.35	1.00	424.35	4.000	No	No	2.00
56	9.35	339.72	1.43	0.91	0.42	457.22	1.00	457.22	4.000	No	No	2.00
57	9.51	384.25	1.35	0.76	0.38	500.68	1.00	500.68	4.000	No	No	2.00
58	9.68	430.92	1.29	0.69	0.36	548.51	1.00	548.51	4.000	No	No	2.00
59	9.84	432.16	1.30	0.72	0.37	550.17	1.00	550.17	4.000	No	No	2.00
60	10.01	387.29	1.40	0.90	0.41	506.01	1.00	506.01	4.000	No	No	2.00
61	10.17	321.69	1.50	1.05	0.44	430.42	1.00	430.42	4.000	No	No	2.00
62	10.34	288.85	1.52	1.03	0.45	386.65	1.00	386.65	4.000	No	No	2.00
63	10.50	283.44	1.49	0.93	0.44	374.58	1.00	374.58	4.000	No	No	2.00
64	10.66	290.08	1.46	0.85	0.43	377.96	1.00	377.96	4.000	No	No	2.00
65	10.83	279.98	1.46	0.84	0.43	363.41	1.00	363.41	4.000	No	No	2.00
66	10.99	249.24	1.48	0.80	0.44	323.75	1.00	323.75	4.000	No	No	2.00
67	11.16	200.04	1.57	0.90	0.47	265.29	1.00	265.29	4.000	No	No	2.00
68	11.32	146.80	1.74	1.19	0.54	202.50	1.07	215.68	4.000	No	No	2.00
69	11.48	118.26	1.83	1.30	0.57	166.02	1.13	187.35	0.692	No	No	0.51
70	11.65	105.96	1.83	1.17	0.57	147.88	1.13	167.07	0.514	No	No	0.38
71	11.81	109.20	1.75	0.89	0.54	148.42	1.07	158.83	0.453	No	No	0.33
72	11.98	106.34	1.80	1.04	0.56	145.71	1.11	161.22	0.470	No	No	0.34
73	12.14	120.48	1.77	1.06	0.55	163.13	1.08	176.96	0.595	No	No	0.43
74	12.30	143.02	1.71	1.01	0.53	189.94	1.04	198.10	0.803	No	No	0.58
75	12.47	156.95	1.68	1.00	0.52	206.16	1.03	211.38	4.000	No	No	2.00
76	12.63	151.14	1.75	1.22	0.54	200.96	1.07	215.55	4.000	No	No	2.00
77	12.80	146.64	1.80	1.37	0.56	196.04	1.10	216.50	4.000	No	No	2.00
78	12.96	154.78	1.76	1.28	0.55	204.24	1.08	220.53	4.000	No	No	2.00
79	13.12	167.54	1.69	1.08	0.52	216.48	1.03	223.29	4.000	No	No	2.00
80	13.29	177.87	1.63	0.92	0.50	225.55	1.00	225.55	4.000	No	No	2.00
81	13.45	183.67	1.60	0.86	0.49	230.41	1.00	230.41	4.000	No	No	2.00
82	13.62	183.17	1.61	0.90	0.49	229.53	1.00	229.53	4.000	No	No	2.00
83	13.78	183.47	1.66	1.06	0.51	231.50	1.01	234.69	4.000	No	No	2.00
84	13.94	188.44	1.70	1.21	0.53	238.53	1.04	247.53	4.000	No	No	2.00
85	14.11	201.04	1.65	1.10	0.51	250.89	1.01	252.47	4.000	No	No	2.00
86	14.27	205.57	1.66	1.12	0.51	255.57	1.01	257.57	4.000	No	No	2.00
87	14.44	181.10	1.74	1.33	0.54	228.06	1.07	243.57	4.000	Yes	No	2.00
88	14.60	131.30	1.97	2.05	0.63	171.78	1.26	216.28	4.000	Yes	No	2.00
89	14.76	79.22	2.23	3.07	0.73	108.13	1.74	188.62	4.000	Yes	No	2.00
90	14.93	48.32	2.48	4.43	0.83	68.31	2.68	182.94	4.000	Yes	No	2.00
91	15.09	44.20	2.49	4.16	0.83	62.05	2.71	168.45	4.000	Yes	No	2.00
92	15.26	61.94	2.25	2.57	0.74	83.07	1.80	149.28	4.000	Yes	No	2.00
93	15.42	92.27	1.97	1.46	0.63	117.41	1.26	148.14	4.000	Yes	No	2.00
94	15.58	131.07	1.73	0.92	0.54	159.53	1.06	169.32	4.000	Yes	No	2.00
95	15.75	172.37	1.60	0.76	0.49	204.19	1.00	204.19	4.000	No	No	2.00
96	15.91	215.60	1.52	0.73	0.46	251.34	1.00	251.34	4.000	No	No	2.00

:: Cyclic Resistance Ratio (CRR) calculation data :: (continued)												
Point ID	Depth (ft)	q_t (tsf)	I_c	Fr (%)	n	Q_{tn}	K_c	$Q_{tn,cs}$	CRR _{7.5}	Belongs to trans. layer	Clay-like behaviour	FS
97	16.08	251.50	1.50	0.79	0.45	291.21	1.00	291.21	4.000	No	No	2.00
98	16.24	275.77	1.50	0.84	0.45	318.06	1.00	318.06	4.000	No	No	2.00
99	16.40	290.97	1.49	0.86	0.45	334.24	1.00	334.24	4.000	No	No	2.00
100	16.57	300.10	1.50	0.89	0.45	343.68	1.00	343.68	4.000	No	No	2.00
101	16.73	305.20	1.51	0.93	0.46	348.91	1.00	348.91	4.000	No	No	2.00
102	16.90	307.50	1.52	0.97	0.46	350.86	1.00	350.86	4.000	No	No	2.00
103	17.06	306.24	1.53	0.98	0.46	348.53	1.00	348.53	4.000	No	No	2.00
104	17.23	298.30	1.54	1.01	0.47	339.02	1.00	339.02	4.000	No	No	2.00
105	17.39	284.83	1.58	1.09	0.49	324.36	1.00	324.36	4.000	No	No	2.00
106	17.55	272.87	1.64	1.24	0.51	311.95	1.00	311.95	4.000	No	No	2.00
107	17.72	272.30	1.64	1.27	0.51	310.41	1.00	310.30	4.000	No	No	2.00
108	17.88	292.33	1.60	1.16	0.49	329.85	1.00	329.85	4.000	No	No	2.00
109	18.05	325.94	1.54	1.06	0.47	363.64	1.00	363.64	4.000	No	No	2.00
110	18.21	364.91	1.51	1.04	0.46	403.97	1.00	403.97	4.000	No	No	2.00
111	18.37	394.01	1.49	1.04	0.45	433.93	1.00	433.93	4.000	No	No	2.00
112	18.54	401.35	1.48	1.02	0.45	439.86	1.00	439.86	4.000	No	No	2.00
113	18.70	382.61	1.48	1.00	0.45	417.99	1.00	417.99	4.000	No	No	2.00
114	18.87	338.14	1.53	1.03	0.47	369.86	1.00	369.86	4.000	No	No	2.00
115	19.03	272.27	1.63	1.17	0.51	300.06	1.00	300.06	4.000	No	No	2.00
116	19.19	192.49	1.80	1.50	0.57	215.32	1.11	238.32	4.000	No	No	2.00
117	19.36	116.99	2.06	2.22	0.67	133.72	1.39	186.17	0.680	No	No	0.45
118	19.52	67.09	2.36	3.44	0.79	78.29	2.16	168.92	0.528	No	No	0.35
119	19.69	62.17	2.39	3.50	0.80	72.27	2.27	163.97	0.490	No	No	0.32
120	19.85	91.29	2.12	2.07	0.69	103.25	1.49	153.47	0.416	No	No	0.27
121	20.01	131.05	1.84	1.18	0.59	144.02	1.14	163.91	0.490	No	No	0.32
122	20.18	155.64	1.70	0.86	0.54	168.19	1.04	174.40	0.573	No	No	0.38
123	20.34	163.97	1.69	0.88	0.53	176.51	1.03	181.91	0.640	No	No	0.42
124	20.51	171.06	1.71	0.98	0.54	183.92	1.04	192.04	0.739	No	No	0.48
125	20.67	184.03	1.71	1.06	0.54	197.32	1.05	206.32	4.000	No	No	2.00
126	20.83	194.82	1.71	1.12	0.54	208.30	1.05	218.08	4.000	No	No	2.00
127	21.00	203.15	1.73	1.24	0.55	216.87	1.06	230.16	4.000	No	No	2.00
128	21.16	203.55	1.70	1.12	0.54	215.95	1.04	224.62	4.000	No	No	2.00
129	21.33	209.68	1.67	1.04	0.53	221.13	1.02	225.33	4.000	No	No	2.00
130	21.49	223.48	1.64	1.01	0.52	234.46	1.00	234.30	4.000	No	No	2.00
131	21.65	245.31	1.66	1.15	0.52	257.01	1.01	260.02	4.000	No	No	2.00
132	21.82	272.88	1.65	1.19	0.52	284.70	1.00	284.93	4.000	No	No	2.00
133	21.98	297.58	1.62	1.16	0.51	308.85	1.00	308.85	4.000	No	No	2.00
134	22.15	319.58	1.60	1.15	0.50	330.18	1.00	330.18	4.000	No	No	2.00
135	22.31	334.31	1.58	1.13	0.49	343.95	1.00	343.95	4.000	No	No	2.00
136	22.47	344.75	1.55	1.07	0.48	352.97	1.00	352.97	4.000	No	No	2.00
137	22.64	351.51	1.53	1.00	0.47	358.14	1.00	358.14	4.000	No	No	2.00
138	22.80	355.95	1.52	0.98	0.47	361.36	1.00	361.36	4.000	No	No	2.00
139	22.97	356.21	1.53	1.01	0.47	360.71	1.00	360.71	4.000	No	No	2.00
140	23.13	352.44	1.53	1.02	0.48	355.97	1.00	355.97	4.000	No	No	2.00
141	23.30	342.61	1.53	1.00	0.48	344.93	1.00	344.93	4.000	No	No	2.00
142	23.46	327.54	1.55	0.99	0.48	328.92	1.00	328.92	4.000	No	No	2.00
143	23.62	315.14	1.58	1.06	0.50	316.02	1.00	316.02	4.000	No	No	2.00
144	23.79	310.08	1.63	1.20	0.51	310.58	1.00	310.58	4.000	No	No	2.00

:: Cyclic Resistance Ratio (CRR) calculation data :: (continued)												
Point ID	Depth (ft)	q _t (tsf)	I _c	Fr (%)	n	Q _{tn}	K _c	Q _{tn,cs}	CRR _{7.5}	Belongs to trans. layer	Clay-like behaviour	FS
145	23.95	315.65	1.65	1.28	0.52	315.46	1.00	315.53	4.000	No	No	2.00
146	24.12	326.65	1.58	1.10	0.50	324.57	1.00	324.57	4.000	No	No	2.00
147	24.28	337.11	1.53	0.95	0.48	333.30	1.00	333.30	4.000	No	No	2.00
148	24.44	339.58	1.49	0.86	0.46	334.35	1.00	334.35	4.000	No	No	2.00
149	24.61	329.12	1.52	0.90	0.47	323.34	1.00	323.34	4.000	No	No	2.00
150	24.77	304.59	1.53	0.87	0.48	298.44	1.00	298.44	4.000	No	No	2.00
151	24.94	260.48	1.62	1.00	0.51	254.99	1.00	254.99	4.000	No	No	2.00
152	25.10	196.71	1.77	1.25	0.57	192.46	1.09	209.06	4.000	No	No	2.00
153	25.26	132.64	1.97	1.60	0.65	129.53	1.26	163.27	0.485	No	No	0.31
154	25.43	83.35	2.12	1.63	0.70	80.82	1.49	120.57	0.243	No	No	0.16
155	25.59	56.92	2.33	2.17	0.78	54.75	2.04	111.87	0.210	No	No	0.14
156	25.76	50.20	2.40	2.40	0.81	47.97	2.32	111.05	0.207	No	No	0.13
157	25.92	61.74	2.36	2.61	0.80	59.08	2.15	127.07	0.271	No	No	0.17
158	26.08	80.44	2.25	2.37	0.75	77.01	1.79	137.90	0.324	No	No	0.21
159	26.25	103.18	2.19	2.46	0.73	98.72	1.63	160.99	0.468	No	No	0.30
160	26.41	159.12	1.98	1.93	0.65	152.12	1.28	194.03	0.759	No	No	0.49
161	26.58	243.59	1.77	1.46	0.57	232.31	1.09	252.27	4.000	No	No	2.00
162	26.74	323.78	1.63	1.21	0.52	307.97	1.00	307.97	4.000	No	No	2.00
163	26.90	356.01	1.59	1.15	0.50	337.71	1.00	337.71	4.000	No	No	2.00
164	27.07	339.37	1.62	1.20	0.52	320.92	1.00	320.92	4.000	No	No	2.00
165	27.23	293.80	1.64	1.15	0.53	276.84	1.00	276.36	4.000	No	No	2.00
166	27.40	231.69	1.65	0.96	0.53	217.34	1.00	218.20	4.000	No	No	2.00
167	27.56	168.08	1.66	0.70	0.53	156.82	1.01	158.63	0.451	No	No	0.29
168	27.72	111.25	1.84	0.79	0.60	102.92	1.13	116.80	0.228	No	No	0.15
169	27.89	69.59	2.23	1.82	0.75	63.43	1.74	110.53	0.206	No	No	0.13
170	28.05	85.93	2.17	1.90	0.73	78.47	1.61	126.09	0.266	No	No	0.17
171	28.22	137.47	1.93	1.38	0.64	126.34	1.22	153.72	0.418	No	No	0.27
172	28.38	195.54	1.73	1.02	0.56	180.24	1.06	190.20	0.720	No	No	0.46
173	28.54	208.03	1.69	0.95	0.54	191.42	1.03	197.14	0.792	No	No	0.51
174	28.71	188.59	1.78	1.16	0.58	172.65	1.09	188.64	0.704	No	No	0.45
175	28.87	148.12	1.95	1.55	0.64	134.48	1.24	166.19	0.507	No	No	0.33
176	29.04	106.86	2.17	2.29	0.73	95.83	1.60	152.98	0.413	No	No	0.26
177	29.20	89.50	2.25	2.47	0.76	79.58	1.80	143.21	0.353	No	No	0.23
178	29.36	129.27	2.01	1.62	0.67	115.90	1.31	151.50	0.403	No	No	0.26
179	29.53	199.51	1.74	1.06	0.57	180.31	1.06	191.98	0.738	No	No	0.47
180	29.69	274.01	1.58	0.87	0.51	248.61	1.00	248.61	4.000	No	No	2.00
181	29.86	321.38	1.51	0.81	0.48	291.65	1.00	291.65	4.000	No	No	2.00
182	30.02	349.58	1.47	0.78	0.47	317.00	1.00	317.00	4.000	No	No	2.00
183	30.19	358.25	1.44	0.71	0.45	324.47	1.00	324.47	4.000	No	No	2.00
184	30.35	346.34	1.46	0.74	0.46	312.71	1.00	312.71	4.000	No	No	2.00
185	30.51	306.60	1.57	0.92	0.50	274.95	1.00	274.95	4.000	No	No	2.00
186	30.68	236.40	1.74	1.21	0.57	209.74	1.06	222.80	4.000	Yes	No	2.00
187	30.84	159.56	1.92	1.46	0.64	139.65	1.20	168.20	4.000	Yes	No	2.00
188	31.01	94.59	2.07	1.40	0.70	81.32	1.41	114.65	4.000	Yes	No	2.00
189	31.17	56.70	2.28	1.52	0.77	47.50	1.88	89.13	4.000	Yes	No	2.00
190	31.33	34.87	2.60	2.64	0.90	28.06	5.56	155.88	4.000	Yes	No	2.00
191	31.50	36.01	2.70	3.82	0.94	28.79	4.00	115.13	4.000	Yes	Yes	2.00
192	31.66	58.12	2.47	3.03	0.85	47.82	2.62	125.35	4.000	Yes	No	2.00

:: Cyclic Resistance Ratio (CRR) calculation data :: (continued)												
Point ID	Depth (ft)	q_t (tsf)	I_c	Fr (%)	n	Q_{tn}	K_c	$Q_{tn,cs}$	CRR _{7.5}	Belongs to trans. layer	Clay-like behaviour	FS
193	31.83	94.76	2.19	2.01	0.74	79.82	1.63	130.44	4.000	Yes	No	2.00
194	31.99	136.15	1.95	1.34	0.65	116.47	1.24	143.90	4.000	Yes	No	2.00
195	32.15	175.68	1.77	0.98	0.58	151.74	1.08	164.53	4.000	Yes	No	2.00
196	32.32	208.34	1.67	0.86	0.55	180.70	1.02	184.26	0.662	No	No	0.43
197	32.48	227.81	1.68	0.95	0.55	197.24	1.02	201.51	4.000	No	No	2.00
198	32.65	242.97	1.72	1.15	0.56	209.40	1.05	220.17	4.000	No	No	2.00
199	32.81	264.47	1.75	1.35	0.57	227.09	1.07	243.29	4.000	No	No	2.00
200	32.97	287.47	1.73	1.36	0.57	246.63	1.06	260.79	4.000	No	No	2.00
201	33.14	301.27	1.69	1.27	0.55	258.36	1.03	267.19	4.000	No	No	2.00
202	33.30	303.97	1.66	1.17	0.54	260.51	1.01	264.08	4.000	No	No	2.00
203	33.47	300.00	1.67	1.18	0.55	256.29	1.02	260.83	4.000	No	No	2.00
204	33.63	291.56	1.70	1.26	0.56	247.87	1.04	257.58	4.000	No	No	2.00
205	33.79	280.43	1.76	1.45	0.58	236.71	1.08	255.78	4.000	No	No	2.00
206	33.96	280.73	1.81	1.64	0.60	235.55	1.11	261.81	4.000	No	No	2.00
207	34.12	290.13	1.78	1.54	0.59	243.34	1.09	265.19	4.000	No	No	2.00
208	34.29	298.43	1.75	1.45	0.58	250.14	1.07	267.85	4.000	No	No	2.00
209	34.45	287.12	1.76	1.45	0.58	239.75	1.08	258.55	4.000	No	No	2.00
210	34.61	262.16	1.86	1.81	0.62	216.42	1.16	250.10	4.000	No	No	2.00
211	34.78	248.33	1.92	2.03	0.64	203.35	1.21	245.58	4.000	No	No	2.00
212	34.94	250.10	1.93	2.10	0.65	204.03	1.22	248.53	4.000	No	No	2.00
213	35.11	266.26	1.89	1.98	0.63	217.30	1.18	257.02	4.000	No	No	2.00
214	35.27	281.09	1.86	1.89	0.62	229.43	1.16	265.11	4.000	No	No	2.00
215	35.43	302.69	1.83	1.80	0.61	247.27	1.13	278.45	4.000	No	No	2.00
216	35.60	332.06	1.79	1.75	0.60	271.43	1.10	298.93	4.000	No	No	2.00
217	35.76	362.49	1.77	1.73	0.59	296.34	1.08	321.04	4.000	No	No	2.00
218	35.93	382.60	1.76	1.75	0.58	312.20	1.08	336.50	4.000	No	No	2.00
219	36.09	385.83	1.77	1.79	0.59	313.82	1.08	339.63	4.000	No	No	2.00
220	36.26	373.10	1.78	1.83	0.59	302.07	1.09	330.31	4.000	No	No	2.00
221	36.42	349.33	1.79	1.78	0.60	281.73	1.10	309.57	4.000	No	No	2.00
222	36.58	314.39	1.80	1.68	0.60	252.52	1.10	278.78	4.000	No	No	2.00
223	36.75	260.05	1.88	1.82	0.63	206.24	1.17	241.15	4.000	No	No	2.00
224	36.91	187.85	2.07	2.44	0.71	145.14	1.41	204.35	4.000	No	No	2.00
225	37.08	155.59	2.25	3.48	0.77	117.32	1.80	211.19	4.000	No	No	2.00
226	37.24	201.17	2.10	2.75	0.72	154.18	1.45	223.43	4.000	No	No	2.00
227	37.40	300.71	1.89	2.08	0.64	235.84	1.18	278.01	4.000	No	No	2.00
228	37.57	393.18	1.77	1.80	0.59	312.10	1.08	338.46	4.000	No	No	2.00
229	37.73	444.95	1.76	1.90	0.59	352.88	1.08	380.44	4.000	No	No	2.00
230	37.90	474.92	1.74	1.88	0.58	376.48	1.07	401.40	4.000	No	No	2.00
231	38.06	484.12	1.71	1.77	0.57	384.02	1.05	402.38	4.000	No	No	2.00
232	38.22	478.08	1.69	1.66	0.56	379.18	1.03	391.93	4.000	No	No	2.00
233	38.39	459.72	1.69	1.61	0.56	363.65	1.03	375.50	4.000	No	No	2.00
234	38.55	439.42	1.69	1.56	0.56	346.63	1.03	358.04	4.000	No	No	2.00
235	38.72	420.05	1.70	1.53	0.57	330.23	1.04	342.08	4.000	No	No	2.00
236	38.88	406.15	1.71	1.54	0.57	318.07	1.04	331.62	4.000	No	No	2.00
237	39.04	397.28	1.70	1.47	0.57	310.71	1.04	321.84	4.000	No	No	2.00
238	39.21	392.41	1.69	1.44	0.57	306.17	1.03	316.68	4.000	No	No	2.00
239	39.37	393.15	1.69	1.42	0.56	306.28	1.03	315.32	4.000	No	No	2.00
240	39.54	397.98	1.69	1.45	0.57	309.04	1.03	319.41	4.000	No	No	2.00

:: Cyclic Resistance Ratio (CRR) calculation data :: (continued)												
Point ID	Depth (ft)	q_t (tsf)	I_c	Fr (%)	n	Q_{tn}	K_c	$Q_{tn,cs}$	CRR _{7.5}	Belongs to trans. layer	Clay-like behaviour	FS
241	39.70	407.99	1.69	1.44	0.56	316.45	1.03	325.21	4.000	No	No	2.00
242	39.86	419.66	1.66	1.37	0.55	325.79	1.01	329.52	4.000	No	No	2.00
243	40.03	434.49	1.65	1.37	0.55	337.01	1.00	338.34	4.000	No	No	2.00
244	40.19	451.72	1.62	1.31	0.54	350.87	1.00	350.87	4.000	No	No	2.00
245	40.36	469.62	1.63	1.35	0.54	363.84	1.00	363.84	4.000	No	No	2.00
246	40.52	488.66	1.61	1.32	0.54	378.67	1.00	378.67	4.000	No	No	2.00
247	40.68	497.92	1.63	1.42	0.54	383.84	1.00	383.84	4.000	No	No	2.00
248	40.85	511.29	1.63	1.45	0.55	393.16	1.00	393.16	4.000	No	No	2.00
249	41.01	513.59	1.65	1.52	0.55	393.05	1.01	395.15	4.000	No	No	2.00
250	41.18	515.26	1.64	1.49	0.55	393.84	1.00	393.68	4.000	No	No	2.00
251	41.34	500.02	1.63	1.41	0.55	381.92	1.00	381.92	4.000	No	No	2.00
252	41.50	482.19	1.61	1.29	0.54	368.69	1.00	368.69	4.000	No	No	2.00
253	41.67	452.88	1.59	1.16	0.53	346.49	1.00	346.49	4.000	No	No	2.00
254	41.83	414.34	1.57	1.04	0.52	316.81	1.00	316.81	4.000	No	No	2.00
255	42.00	359.84	1.60	0.99	0.53	273.34	1.00	273.34	4.000	No	No	2.00
256	42.16	286.83	1.70	1.10	0.57	213.54	1.04	221.83	4.000	Yes	No	2.00
257	42.32	201.19	1.91	1.46	0.65	144.22	1.20	172.40	4.000	Yes	No	2.00
258	42.49	124.61	2.18	2.11	0.76	84.66	1.62	137.47	4.000	Yes	No	2.00
259	42.65	76.68	2.41	2.53	0.84	49.46	2.33	115.44	4.000	Yes	No	2.00
260	42.82	56.29	2.51	2.43	0.88	35.14	2.92	102.56	4.000	Yes	No	2.00
261	42.98	45.94	2.55	2.16	0.90	28.07	3.92	110.12	0.204	No	No	0.14
262	43.15	37.25	2.68	2.52	0.95	21.91	8.77	192.04	0.739	No	No	0.51
263	43.31	29.67	2.83	3.10	1.00	16.65	5.01	83.41	0.794	No	Yes	0.55
264	43.47	25.67	2.90	3.36	1.00	14.13	5.73	80.97	0.674	No	Yes	0.47
265	43.64	25.43	2.91	3.39	1.00	13.93	5.81	80.92	0.665	No	Yes	0.46
266	43.80	27.03	2.89	3.44	1.00	14.88	5.62	83.67	0.710	No	Yes	0.50
267	43.97	28.55	2.87	3.37	1.00	15.76	5.38	84.81	0.752	No	Yes	0.53
268	44.13	29.45	2.86	3.38	1.00	16.26	5.29	86.03	0.776	No	Yes	0.54
269	44.29	29.25	2.85	3.29	1.00	16.09	5.25	84.49	0.767	No	Yes	0.54
270	44.46	27.78	2.90	3.61	1.00	15.14	5.69	86.15	0.722	No	Yes	0.51
271	44.62	27.36	2.91	3.68	1.00	14.84	5.80	86.12	0.708	No	Yes	0.50
272	44.79	27.89	2.90	3.60	1.00	15.12	5.68	85.94	0.721	No	Yes	0.51
273	44.95	29.63	2.86	3.37	1.00	16.12	5.31	85.53	0.769	No	Yes	0.54
274	45.11	30.10	2.85	3.31	1.00	16.35	5.22	85.34	0.780	No	Yes	0.55
275	45.28	29.92	2.85	3.33	1.00	16.19	5.27	85.29	0.772	No	Yes	0.55
276	45.44	29.76	2.85	3.23	1.00	16.05	5.22	83.76	0.765	No	Yes	0.54
277	45.61	29.37	2.84	3.03	1.00	15.77	5.12	80.73	0.752	No	Yes	0.53
278	45.77	28.99	2.83	2.82	1.00	15.49	5.01	77.60	0.739	No	Yes	0.53
279	45.93	28.38	2.83	2.75	1.00	15.09	5.04	76.04	0.720	No	Yes	0.51
280	46.10	27.73	2.83	2.69	1.00	14.66	5.08	74.46	0.699	No	Yes	0.50
281	46.26	27.08	2.82	2.49	1.00	14.23	5.00	71.14	0.679	No	Yes	0.48
282	46.43	26.34	2.82	2.28	1.00	13.75	4.92	67.67	0.656	No	Yes	0.47
283	46.59	25.48	2.82	2.22	1.00	13.21	4.99	65.93	0.630	No	Yes	0.45
284	46.75	24.82	2.83	2.14	1.00	12.79	5.01	64.10	0.610	No	Yes	0.44
285	46.92	24.64	2.81	2.00	1.00	12.64	4.91	62.12	0.603	No	Yes	0.43
286	47.08	24.30	2.81	1.88	1.00	12.41	4.84	60.12	0.592	No	Yes	0.43
287	47.25	23.60	2.83	1.95	1.00	11.97	5.03	60.18	0.571	No	Yes	0.41
288	47.41	22.34	2.85	1.90	1.00	11.21	5.20	58.25	0.535	No	Yes	0.39

:: Cyclic Resistance Ratio (CRR) calculation data :: (continued)												
Point ID	Depth (ft)	q_t (tsf)	I_c	Fr (%)	n	Q_{tn}	K_c	$Q_{tn,cs}$	$CRR_{7.5}$	Belongs to trans. layer	Clay-like behaviour	FS
289	47.57	21.29	2.86	1.83	1.00	10.57	5.32	56.18	0.504	No	Yes	0.36
290	47.74	20.38	2.89	1.93	1.00	10.01	5.62	56.23	0.477	No	Yes	0.35
291	47.90	19.82	2.99	2.79	1.00	9.66	6.65	64.21	0.461	No	Yes	0.33
292	48.07	19.90	3.15	5.15	1.00	9.68	8.53	82.56	0.462	No	Yes	0.34
293	48.23	35.29	2.91	4.87	1.00	18.47	5.84	107.85	4.000	Yes	Yes	2.00
294	48.39	81.12	2.48	3.08	0.88	47.47	2.65	125.97	4.000	Yes	No	2.00
295	48.56	129.16	2.26	2.57	0.79	79.72	1.83	145.96	4.000	Yes	No	2.00
296	48.72	169.58	2.16	2.44	0.76	107.10	1.57	168.29	4.000	Yes	No	2.00
297	48.89	169.24	2.19	2.69	0.77	105.87	1.65	174.70	0.576	No	No	0.42
298	49.05	165.45	2.19	2.61	0.77	103.23	1.64	169.69	0.534	No	No	0.39
299	49.22	169.49	2.13	2.22	0.75	106.79	1.51	161.30	0.470	No	No	0.35
300	49.38	218.93	1.92	1.53	0.67	144.01	1.21	174.25	0.572	No	No	0.42
301	49.54	269.30	1.78	1.23	0.61	182.24	1.09	199.35	0.817	No	No	0.60

Abbreviations

Depth:	Depth from free surface, at which CPT was performed (ft)
q_t :	Total cone resistance
I_c :	Soil behavior type index
Fr:	Normalized friction ratio (%)
n:	Stress exponent
Q_{tn} :	Normalized cone resistance
K_c :	Cone resistance correction factor due to fines
$Q_{tn,cs}$:	Normalized and adjusted cone resistance
$CRR_{7.5}$:	Cyclic resistance ratio for $M_w=7.5$
FS:	Factor of safety against soil liquefaction

:: Liquefaction Potential Index calculation data ::											
Depth (ft)	FS	F_L	w_z	d_z	LPI	Depth (ft)	FS	F_L	w_z	d_z	LPI
0.33	2.00	0.00	9.95	0.16	0.00	0.49	2.00	0.00	9.93	0.16	0.00
0.66	2.00	0.00	9.90	0.17	0.00	0.82	2.00	0.00	9.88	0.16	0.00
0.98	2.00	0.00	9.85	0.16	0.00	1.15	2.00	0.00	9.82	0.17	0.00
1.31	2.00	0.00	9.80	0.16	0.00	1.48	2.00	0.00	9.77	0.17	0.00
1.64	2.00	0.00	9.75	0.16	0.00	1.80	2.00	0.00	9.73	0.16	0.00
1.97	2.00	0.00	9.70	0.17	0.00	2.13	2.00	0.00	9.68	0.16	0.00
2.30	2.00	0.00	9.65	0.17	0.00	2.46	2.00	0.00	9.63	0.16	0.00
2.62	2.00	0.00	9.60	0.16	0.00	2.79	2.00	0.00	9.57	0.17	0.00
2.95	2.00	0.00	9.55	0.16	0.00	3.12	2.00	0.00	9.52	0.17	0.00
3.28	2.00	0.00	9.50	0.16	0.00	3.45	2.00	0.00	9.47	0.17	0.00
3.61	2.00	0.00	9.45	0.16	0.00	3.77	2.00	0.00	9.43	0.16	0.00
3.94	2.00	0.00	9.40	0.17	0.00	4.10	2.00	0.00	9.38	0.16	0.00
4.27	2.00	0.00	9.35	0.17	0.00	4.43	2.00	0.00	9.32	0.16	0.00
4.59	2.00	0.00	9.30	0.16	0.00	4.76	2.00	0.00	9.27	0.17	0.00
4.92	2.00	0.00	9.25	0.16	0.00	5.09	2.00	0.00	9.22	0.17	0.00
5.25	2.00	0.00	9.20	0.16	0.00	5.41	2.00	0.00	9.18	0.16	0.00
5.58	2.00	0.00	9.15	0.17	0.00	5.74	2.00	0.00	9.13	0.16	0.00
5.91	2.00	0.00	9.10	0.17	0.00	6.07	2.00	0.00	9.07	0.16	0.00
6.23	2.00	0.00	9.05	0.16	0.00	6.40	2.00	0.00	9.02	0.17	0.00
6.56	2.00	0.00	9.00	0.16	0.00	6.73	2.00	0.00	8.97	0.17	0.00
6.89	2.00	0.00	8.95	0.16	0.00	7.05	2.00	0.00	8.93	0.16	0.00
7.22	2.00	0.00	8.90	0.17	0.00	7.38	2.00	0.00	8.88	0.16	0.00
7.55	2.00	0.00	8.85	0.17	0.00	7.71	0.39	0.61	8.82	0.16	0.26
7.87	0.52	0.48	8.80	0.16	0.21	8.04	2.00	0.00	8.77	0.17	0.00
8.20	2.00	0.00	8.75	0.16	0.00	8.37	2.00	0.00	8.72	0.17	0.00
8.53	2.00	0.00	8.70	0.16	0.00	8.69	2.00	0.00	8.68	0.16	0.00
8.86	2.00	0.00	8.65	0.17	0.00	9.02	2.00	0.00	8.63	0.16	0.00
9.19	2.00	0.00	8.60	0.17	0.00	9.35	2.00	0.00	8.58	0.16	0.00
9.51	2.00	0.00	8.55	0.16	0.00	9.68	2.00	0.00	8.52	0.17	0.00
9.84	2.00	0.00	8.50	0.16	0.00	10.01	2.00	0.00	8.47	0.17	0.00
10.17	2.00	0.00	8.45	0.16	0.00	10.34	2.00	0.00	8.42	0.17	0.00
10.50	2.00	0.00	8.40	0.16	0.00	10.66	2.00	0.00	8.38	0.16	0.00
10.83	2.00	0.00	8.35	0.17	0.00	10.99	2.00	0.00	8.33	0.16	0.00
11.16	2.00	0.00	8.30	0.17	0.00	11.32	2.00	0.00	8.27	0.16	0.00
11.48	0.51	0.49	8.25	0.16	0.20	11.65	0.38	0.62	8.22	0.17	0.27
11.81	0.33	0.67	8.20	0.16	0.27	11.98	0.34	0.66	8.17	0.17	0.28
12.14	0.43	0.57	8.15	0.16	0.23	12.30	0.58	0.42	8.13	0.16	0.17
12.47	2.00	0.00	8.10	0.17	0.00	12.63	2.00	0.00	8.08	0.16	0.00
12.80	2.00	0.00	8.05	0.17	0.00	12.96	2.00	0.00	8.02	0.16	0.00
13.12	2.00	0.00	8.00	0.16	0.00	13.29	2.00	0.00	7.97	0.17	0.00
13.45	2.00	0.00	7.95	0.16	0.00	13.62	2.00	0.00	7.92	0.17	0.00
13.78	2.00	0.00	7.90	0.16	0.00	13.94	2.00	0.00	7.88	0.16	0.00
14.11	2.00	0.00	7.85	0.17	0.00	14.27	2.00	0.00	7.83	0.16	0.00
14.44	2.00	0.00	7.80	0.17	0.00	14.60	2.00	0.00	7.77	0.16	0.00
14.76	2.00	0.00	7.75	0.16	0.00	14.93	2.00	0.00	7.72	0.17	0.00
15.09	2.00	0.00	7.70	0.16	0.00	15.26	2.00	0.00	7.67	0.17	0.00
15.42	2.00	0.00	7.65	0.16	0.00	15.58	2.00	0.00	7.63	0.16	0.00
15.75	2.00	0.00	7.60	0.17	0.00	15.91	2.00	0.00	7.58	0.16	0.00

:: Liquefaction Potential Index calculation data :: (continued)											
Depth (ft)	FS	F_L	w_z	d_z	LPI	Depth (ft)	FS	F_L	w_z	d_z	LPI
16.08	2.00	0.00	7.55	0.17	0.00	16.24	2.00	0.00	7.53	0.16	0.00
16.40	2.00	0.00	7.50	0.16	0.00	16.57	2.00	0.00	7.47	0.17	0.00
16.73	2.00	0.00	7.45	0.16	0.00	16.90	2.00	0.00	7.42	0.17	0.00
17.06	2.00	0.00	7.40	0.16	0.00	17.23	2.00	0.00	7.37	0.17	0.00
17.39	2.00	0.00	7.35	0.16	0.00	17.55	2.00	0.00	7.33	0.16	0.00
17.72	2.00	0.00	7.30	0.17	0.00	17.88	2.00	0.00	7.28	0.16	0.00
18.05	2.00	0.00	7.25	0.17	0.00	18.21	2.00	0.00	7.22	0.16	0.00
18.37	2.00	0.00	7.20	0.16	0.00	18.54	2.00	0.00	7.17	0.17	0.00
18.70	2.00	0.00	7.15	0.16	0.00	18.87	2.00	0.00	7.12	0.17	0.00
19.03	2.00	0.00	7.10	0.16	0.00	19.19	2.00	0.00	7.08	0.16	0.00
19.36	0.45	0.55	7.05	0.17	0.20	19.52	0.35	0.65	7.03	0.16	0.22
19.69	0.32	0.68	7.00	0.17	0.25	19.85	0.27	0.73	6.97	0.16	0.25
20.01	0.32	0.68	6.95	0.16	0.23	20.18	0.38	0.62	6.92	0.17	0.22
20.34	0.42	0.58	6.90	0.16	0.20	20.51	0.48	0.52	6.87	0.17	0.18
20.67	2.00	0.00	6.85	0.16	0.00	20.83	2.00	0.00	6.83	0.16	0.00
21.00	2.00	0.00	6.80	0.17	0.00	21.16	2.00	0.00	6.78	0.16	0.00
21.33	2.00	0.00	6.75	0.17	0.00	21.49	2.00	0.00	6.72	0.16	0.00
21.65	2.00	0.00	6.70	0.16	0.00	21.82	2.00	0.00	6.67	0.17	0.00
21.98	2.00	0.00	6.65	0.16	0.00	22.15	2.00	0.00	6.62	0.17	0.00
22.31	2.00	0.00	6.60	0.16	0.00	22.47	2.00	0.00	6.58	0.16	0.00
22.64	2.00	0.00	6.55	0.17	0.00	22.80	2.00	0.00	6.53	0.16	0.00
22.97	2.00	0.00	6.50	0.17	0.00	23.13	2.00	0.00	6.47	0.16	0.00
23.30	2.00	0.00	6.45	0.17	0.00	23.46	2.00	0.00	6.42	0.16	0.00
23.62	2.00	0.00	6.40	0.16	0.00	23.79	2.00	0.00	6.37	0.17	0.00
23.95	2.00	0.00	6.35	0.16	0.00	24.12	2.00	0.00	6.32	0.17	0.00
24.28	2.00	0.00	6.30	0.16	0.00	24.44	2.00	0.00	6.28	0.16	0.00
24.61	2.00	0.00	6.25	0.17	0.00	24.77	2.00	0.00	6.23	0.16	0.00
24.94	2.00	0.00	6.20	0.17	0.00	25.10	2.00	0.00	6.17	0.16	0.00
25.26	0.31	0.69	6.15	0.16	0.21	25.43	0.16	0.84	6.12	0.17	0.27
25.59	0.14	0.86	6.10	0.16	0.26	25.76	0.13	0.87	6.07	0.17	0.27
25.92	0.17	0.83	6.05	0.16	0.24	26.08	0.21	0.79	6.03	0.16	0.23
26.25	0.30	0.70	6.00	0.17	0.22	26.41	0.49	0.51	5.98	0.16	0.15
26.58	2.00	0.00	5.95	0.17	0.00	26.74	2.00	0.00	5.92	0.16	0.00
26.90	2.00	0.00	5.90	0.16	0.00	27.07	2.00	0.00	5.87	0.17	0.00
27.23	2.00	0.00	5.85	0.16	0.00	27.40	2.00	0.00	5.82	0.17	0.00
27.56	0.29	0.71	5.80	0.16	0.20	27.72	0.15	0.85	5.78	0.16	0.24
27.89	0.13	0.87	5.75	0.17	0.26	28.05	0.17	0.83	5.73	0.16	0.23
28.22	0.27	0.73	5.70	0.17	0.22	28.38	0.46	0.54	5.67	0.16	0.15
28.54	0.51	0.49	5.65	0.16	0.14	28.71	0.45	0.55	5.62	0.17	0.16
28.87	0.33	0.67	5.60	0.16	0.18	29.04	0.26	0.74	5.57	0.17	0.21
29.20	0.23	0.77	5.55	0.16	0.21	29.36	0.26	0.74	5.53	0.16	0.20
29.53	0.47	0.53	5.50	0.17	0.15	29.69	2.00	0.00	5.48	0.16	0.00
29.86	2.00	0.00	5.45	0.17	0.00	30.02	2.00	0.00	5.42	0.16	0.00
30.19	2.00	0.00	5.40	0.17	0.00	30.35	2.00	0.00	5.37	0.16	0.00
30.51	2.00	0.00	5.35	0.16	0.00	30.68	2.00	0.00	5.32	0.17	0.00
30.84	2.00	0.00	5.30	0.16	0.00	31.01	2.00	0.00	5.27	0.17	0.00
31.17	2.00	0.00	5.25	0.16	0.00	31.33	2.00	0.00	5.23	0.16	0.00
31.50	2.00	0.00	5.20	0.17	0.00	31.66	2.00	0.00	5.18	0.16	0.00

:: Liquefaction Potential Index calculation data :: (continued)											
Depth (ft)	FS	F _L	w _z	d _z	LPI	Depth (ft)	FS	F _L	w _z	d _z	LPI
31.83	2.00	0.00	5.15	0.17	0.00	31.99	2.00	0.00	5.12	0.16	0.00
32.15	2.00	0.00	5.10	0.16	0.00	32.32	0.43	0.57	5.07	0.17	0.15
32.48	2.00	0.00	5.05	0.16	0.00	32.65	2.00	0.00	5.02	0.17	0.00
32.81	2.00	0.00	5.00	0.16	0.00	32.97	2.00	0.00	4.98	0.16	0.00
33.14	2.00	0.00	4.95	0.17	0.00	33.30	2.00	0.00	4.93	0.16	0.00
33.47	2.00	0.00	4.90	0.17	0.00	33.63	2.00	0.00	4.87	0.16	0.00
33.79	2.00	0.00	4.85	0.16	0.00	33.96	2.00	0.00	4.82	0.17	0.00
34.12	2.00	0.00	4.80	0.16	0.00	34.29	2.00	0.00	4.77	0.17	0.00
34.45	2.00	0.00	4.75	0.16	0.00	34.61	2.00	0.00	4.73	0.16	0.00
34.78	2.00	0.00	4.70	0.17	0.00	34.94	2.00	0.00	4.68	0.16	0.00
35.11	2.00	0.00	4.65	0.17	0.00	35.27	2.00	0.00	4.62	0.16	0.00
35.43	2.00	0.00	4.60	0.16	0.00	35.60	2.00	0.00	4.57	0.17	0.00
35.76	2.00	0.00	4.55	0.16	0.00	35.93	2.00	0.00	4.52	0.17	0.00
36.09	2.00	0.00	4.50	0.16	0.00	36.26	2.00	0.00	4.47	0.17	0.00
36.42	2.00	0.00	4.45	0.16	0.00	36.58	2.00	0.00	4.43	0.16	0.00
36.75	2.00	0.00	4.40	0.17	0.00	36.91	2.00	0.00	4.37	0.16	0.00
37.08	2.00	0.00	4.35	0.17	0.00	37.24	2.00	0.00	4.32	0.16	0.00
37.40	2.00	0.00	4.30	0.16	0.00	37.57	2.00	0.00	4.27	0.17	0.00
37.73	2.00	0.00	4.25	0.16	0.00	37.90	2.00	0.00	4.22	0.17	0.00
38.06	2.00	0.00	4.20	0.16	0.00	38.22	2.00	0.00	4.18	0.16	0.00
38.39	2.00	0.00	4.15	0.17	0.00	38.55	2.00	0.00	4.12	0.16	0.00
38.72	2.00	0.00	4.10	0.17	0.00	38.88	2.00	0.00	4.07	0.16	0.00
39.04	2.00	0.00	4.05	0.16	0.00	39.21	2.00	0.00	4.02	0.17	0.00
39.37	2.00	0.00	4.00	0.16	0.00	39.54	2.00	0.00	3.97	0.17	0.00
39.70	2.00	0.00	3.95	0.16	0.00	39.86	2.00	0.00	3.93	0.16	0.00
40.03	2.00	0.00	3.90	0.17	0.00	40.19	2.00	0.00	3.88	0.16	0.00
40.36	2.00	0.00	3.85	0.17	0.00	40.52	2.00	0.00	3.82	0.16	0.00
40.68	2.00	0.00	3.80	0.16	0.00	40.85	2.00	0.00	3.77	0.17	0.00
41.01	2.00	0.00	3.75	0.16	0.00	41.18	2.00	0.00	3.72	0.17	0.00
41.34	2.00	0.00	3.70	0.16	0.00	41.50	2.00	0.00	3.68	0.16	0.00
41.67	2.00	0.00	3.65	0.17	0.00	41.83	2.00	0.00	3.63	0.16	0.00
42.00	2.00	0.00	3.60	0.17	0.00	42.16	2.00	0.00	3.57	0.16	0.00
42.32	2.00	0.00	3.55	0.16	0.00	42.49	2.00	0.00	3.52	0.17	0.00
42.65	2.00	0.00	3.50	0.16	0.00	42.82	2.00	0.00	3.47	0.17	0.00
42.98	0.14	0.86	3.45	0.16	0.14	43.15	0.51	0.49	3.42	0.17	0.09
43.31	0.55	0.45	3.40	0.16	0.07	43.47	0.47	0.53	3.38	0.16	0.09
43.64	0.46	0.54	3.35	0.17	0.09	43.80	0.50	0.50	3.32	0.16	0.08
43.97	0.53	0.47	3.30	0.17	0.08	44.13	0.54	0.46	3.27	0.16	0.07
44.29	0.54	0.46	3.25	0.16	0.07	44.46	0.51	0.49	3.22	0.17	0.08
44.62	0.50	0.50	3.20	0.16	0.08	44.79	0.51	0.49	3.17	0.17	0.08
44.95	0.54	0.46	3.15	0.16	0.07	45.11	0.55	0.45	3.13	0.16	0.07
45.28	0.55	0.45	3.10	0.17	0.07	45.44	0.54	0.46	3.07	0.16	0.07
45.61	0.53	0.47	3.05	0.17	0.07	45.77	0.53	0.47	3.02	0.16	0.07
45.93	0.51	0.49	3.00	0.16	0.07	46.10	0.50	0.50	2.97	0.17	0.08
46.26	0.48	0.52	2.95	0.16	0.07	46.43	0.47	0.53	2.92	0.17	0.08
46.59	0.45	0.55	2.90	0.16	0.08	46.75	0.44	0.56	2.88	0.16	0.08
46.92	0.43	0.57	2.85	0.17	0.08	47.08	0.43	0.57	2.83	0.16	0.08
47.25	0.41	0.59	2.80	0.17	0.09	47.41	0.39	0.61	2.77	0.16	0.08

:: Liquefaction Potential Index calculation data :: (continued)

Depth (ft)	FS	F_L	w_z	d_z	LPI	Depth (ft)	FS	F_L	w_z	d_z	LPI
47.57	0.36	0.64	2.75	0.16	0.09	47.74	0.35	0.65	2.72	0.17	0.09
47.90	0.33	0.67	2.70	0.16	0.09	48.07	0.34	0.66	2.67	0.17	0.09
48.23	2.00	0.00	2.65	0.16	0.00	48.39	2.00	0.00	2.63	0.16	0.00
48.56	2.00	0.00	2.60	0.17	0.00	48.72	2.00	0.00	2.58	0.16	0.00
48.89	0.42	0.58	2.55	0.17	0.08	49.05	0.39	0.61	2.52	0.16	0.07
49.22	0.35	0.65	2.50	0.17	0.08	49.38	0.42	0.58	2.47	0.16	0.07
49.54	0.60	0.40	2.45	0.16	0.05						

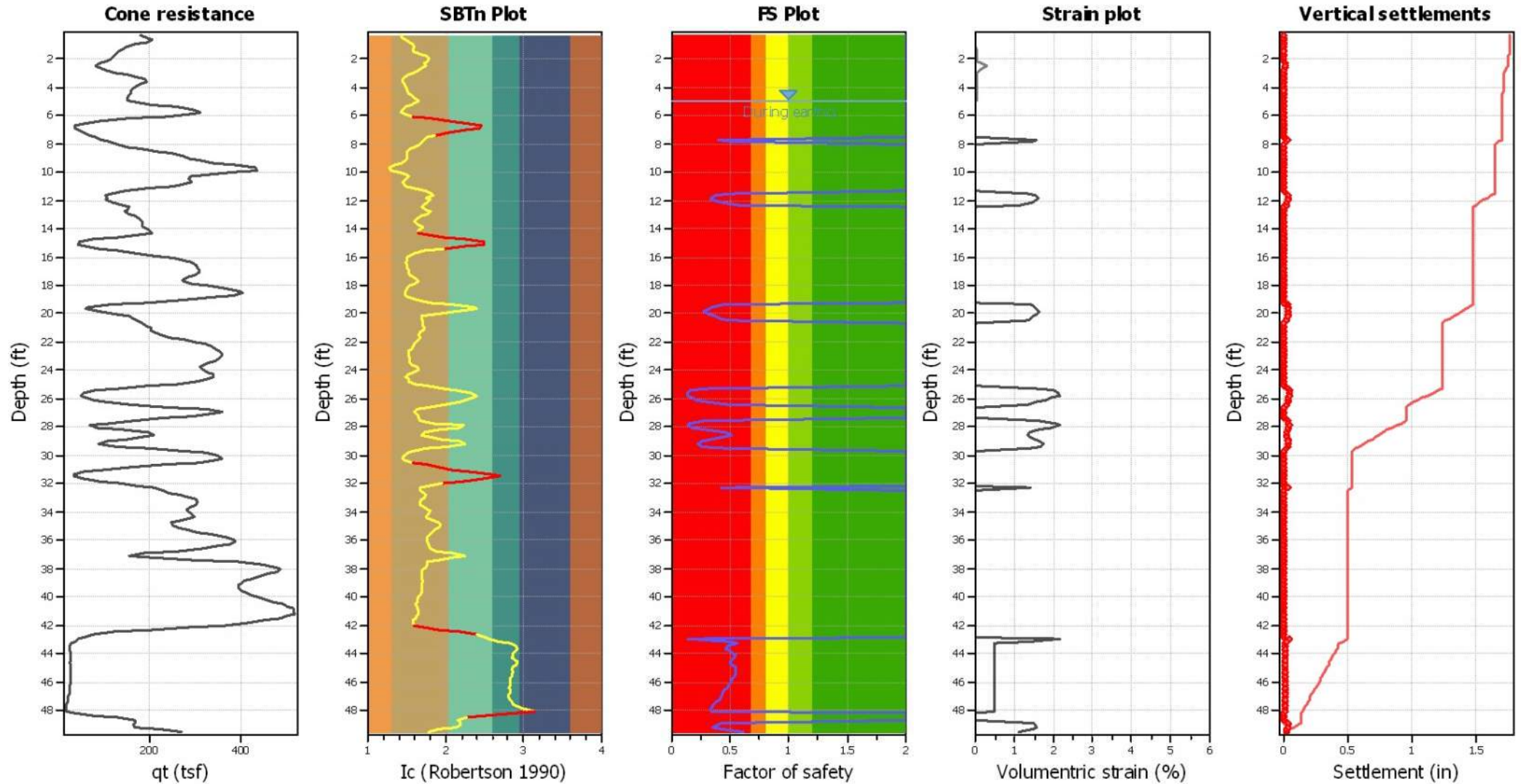
Overall liquefaction potential: 11.13

LPI = 0.00 - Liquefaction risk very low
LPI between 0.00 and 5.00 - Liquefaction risk low
LPI between 5.00 and 15.00 - Liquefaction risk high
LPI > 15.00 - Liquefaction risk very high

Abbreviations

FS: Calculated factor of safety for test point
 F_L : 1 - FS
 w_z : Function value of the extend of soil liquefaction according to depth
 d_z : Layer thickness (ft)
LPI: Liquefaction potential index value for test point

Estimation of post-earthquake settlements



Abbreviations

- qt: Total cone resistance (cone resistance q_c corrected for pore water effects)
- I_c: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post-liquefaction volumetric strain

:: Post-earthquake settlement of dry sands ::													
Depth (ft)	Ic	Kc	Qc1n	Qc1n,cs	N1,60 (blows)	Vs (ft/s)	Gmax (tsf)	CSR	Shear, γ (%)	Svol,15 (%)	Nc	ev (%)	Settle. (in)
0.33	1.43	1.00	342.77	342.77	58	1036.0	291	1.01	0.040	0.01	21.37	0.01	0.000
0.49	1.45	1.00	372.68	372.68	64	1097.7	404	1.01	0.026	0.01	21.37	0.01	0.000
0.66	1.48	1.00	390.93	390.93	68	1145.1	518	1.01	0.020	0.00	21.37	0.01	0.000
0.82	1.54	1.00	366.72	366.72	65	1149.5	583	1.01	0.021	0.01	21.37	0.01	0.000
0.98	1.58	1.00	319.89	319.89	57	1101.7	580	1.01	0.030	0.01	21.37	0.01	0.000
1.15	1.60	1.00	283.01	283.01	51	1049.7	564	1.00	0.045	0.01	21.37	0.02	0.001
1.31	1.57	1.00	261.44	261.44	47	994.3	532	1.00	0.075	0.03	21.37	0.03	0.001
1.48	1.58	1.00	250.33	250.33	45	978.4	544	1.00	0.090	0.03	21.37	0.04	0.002
1.64	1.67	1.02	238.41	242.85	45	1010.2	616	1.00	0.068	0.03	21.37	0.03	0.001
1.80	1.75	1.07	231.90	249.04	47	1049.1	704	1.00	0.050	0.02	21.37	0.02	0.001
1.97	1.79	1.10	219.40	240.79	46	1042.6	726	1.00	0.054	0.02	21.37	0.02	0.001
2.13	1.77	1.09	197.33	214.41	41	979.1	655	1.00	0.094	0.04	21.37	0.05	0.002
2.30	1.73	1.06	172.55	182.60	34	891.8	549	1.00	0.257	0.13	21.37	0.16	0.006
2.46	1.74	1.06	157.66	167.62	32	856.4	517	1.00	0.428	0.25	21.37	0.29	0.011
2.62	1.71	1.05	167.41	175.25	33	869.1	551	1.00	0.356	0.20	21.37	0.23	0.009
2.79	1.65	1.01	198.77	200.07	37	912.3	634	1.00	0.203	0.10	21.37	0.11	0.005
2.95	1.59	1.00	241.85	241.85	43	963.1	736	1.00	0.118	0.05	21.37	0.05	0.002
3.12	1.52	1.00	288.70	288.70	51	1010.9	844	1.00	0.078	0.03	21.37	0.03	0.001
3.28	1.47	1.00	326.78	326.78	57	1040.9	924	1.00	0.063	0.02	21.37	0.02	0.001
3.45	1.44	1.00	344.05	344.05	59	1049.5	968	1.00	0.060	0.02	21.37	0.02	0.001
3.61	1.44	1.00	342.18	342.18	59	1044.6	982	1.00	0.062	0.02	21.37	0.02	0.001
3.77	1.46	1.00	326.04	326.04	56	1032.7	979	1.00	0.069	0.02	21.37	0.02	0.001
3.94	1.48	1.00	300.60	300.60	52	1007.0	946	1.00	0.084	0.03	21.37	0.03	0.001
4.10	1.50	1.00	282.61	282.61	49	988.3	925	1.00	0.099	0.03	21.37	0.04	0.002
4.27	1.51	1.00	272.54	272.54	48	976.0	919	1.00	0.111	0.04	21.37	0.05	0.002
4.43	1.52	1.00	268.40	268.40	47	971.8	928	1.00	0.115	0.04	21.37	0.05	0.002
4.59	1.56	1.00	265.92	265.92	47	992.8	992	1.00	0.097	0.03	21.37	0.04	0.002
4.76	1.61	1.00	263.18	263.18	48	1017.4	1068	1.00	0.081	0.03	21.37	0.03	0.001
4.92	1.66	1.01	263.58	265.50	49	1051.3	1169	1.00	0.065	0.02	21.37	0.03	0.001
Total estimated settlement: 0.06													

:: Post-earthquake settlement due to soil liquefaction ::											
Depth (ft)	Q _{tn,cs}	FS	e _v (%)	DF	Settlement (in)	Depth (ft)	Q _{tn,cs}	FS	e _v (%)	DF	Settlement (in)
5.09	289.55	2.00	0.00	1.00	0.00	5.25	337.89	2.00	0.00	1.00	0.00
5.41	400.40	2.00	0.00	1.00	0.00	5.58	445.48	2.00	0.00	1.00	0.00
5.74	471.07	2.00	0.00	1.00	0.00	5.91	447.53	2.00	0.00	1.00	0.00
6.07	379.49	2.00	0.00	1.00	0.00	6.23	298.55	2.00	0.00	1.00	0.00
6.40	237.23	2.00	0.00	1.00	0.00	6.56	205.87	2.00	0.00	1.00	0.00
6.73	191.87	2.00	0.00	1.00	0.00	6.89	175.40	2.00	0.00	1.00	0.00
7.05	149.49	2.00	0.00	1.00	0.00	7.22	134.66	2.00	0.00	1.00	0.00
7.38	136.10	2.00	0.00	1.00	0.00	7.55	145.62	2.00	0.00	1.00	0.00
7.71	161.62	0.39	1.58	1.00	0.03	7.87	180.24	0.52	1.44	1.00	0.03
8.04	201.55	2.00	0.00	1.00	0.00	8.20	226.24	2.00	0.00	1.00	0.00
8.37	262.00	2.00	0.00	1.00	0.00	8.53	306.54	2.00	0.00	1.00	0.00
8.69	349.75	2.00	0.00	1.00	0.00	8.86	380.51	2.00	0.00	1.00	0.00
9.02	400.81	2.00	0.00	1.00	0.00	9.19	424.35	2.00	0.00	1.00	0.00

:: Post-earthquake settlement due to soil liquefaction :: (continued)											
Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)
9.35	457.22	2.00	0.00	1.00	0.00	9.51	500.68	2.00	0.00	1.00	0.00
9.68	548.51	2.00	0.00	1.00	0.00	9.84	550.17	2.00	0.00	1.00	0.00
10.01	506.01	2.00	0.00	1.00	0.00	10.17	430.42	2.00	0.00	1.00	0.00
10.34	386.65	2.00	0.00	1.00	0.00	10.50	374.58	2.00	0.00	1.00	0.00
10.66	377.96	2.00	0.00	1.00	0.00	10.83	363.41	2.00	0.00	1.00	0.00
10.99	323.75	2.00	0.00	1.00	0.00	11.16	265.29	2.00	0.00	1.00	0.00
11.32	215.68	2.00	0.00	1.00	0.00	11.48	187.35	0.51	1.40	1.00	0.03
11.65	167.07	0.38	1.53	1.00	0.03	11.81	158.83	0.33	1.60	1.00	0.03
11.98	161.22	0.34	1.58	1.00	0.03	12.14	176.96	0.43	1.46	1.00	0.03
12.30	198.10	0.58	1.13	1.00	0.02	12.47	211.38	2.00	0.00	1.00	0.00
12.63	215.55	2.00	0.00	1.00	0.00	12.80	216.50	2.00	0.00	1.00	0.00
12.96	220.53	2.00	0.00	1.00	0.00	13.12	223.29	2.00	0.00	1.00	0.00
13.29	225.55	2.00	0.00	1.00	0.00	13.45	230.41	2.00	0.00	1.00	0.00
13.62	229.53	2.00	0.00	1.00	0.00	13.78	234.69	2.00	0.00	1.00	0.00
13.94	247.53	2.00	0.00	1.00	0.00	14.11	252.47	2.00	0.00	1.00	0.00
14.27	257.57	2.00	0.00	1.00	0.00	14.44	243.57	2.00	0.00	1.00	0.00
14.60	216.28	2.00	0.00	1.00	0.00	14.76	188.62	2.00	0.00	1.00	0.00
14.93	182.94	2.00	0.00	1.00	0.00	15.09	168.45	2.00	0.00	1.00	0.00
15.26	149.28	2.00	0.00	1.00	0.00	15.42	148.14	2.00	0.00	1.00	0.00
15.58	169.32	2.00	0.00	1.00	0.00	15.75	204.19	2.00	0.00	1.00	0.00
15.91	251.34	2.00	0.00	1.00	0.00	16.08	291.21	2.00	0.00	1.00	0.00
16.24	318.06	2.00	0.00	1.00	0.00	16.40	334.24	2.00	0.00	1.00	0.00
16.57	343.68	2.00	0.00	1.00	0.00	16.73	348.91	2.00	0.00	1.00	0.00
16.90	350.86	2.00	0.00	1.00	0.00	17.06	348.53	2.00	0.00	1.00	0.00
17.23	339.02	2.00	0.00	1.00	0.00	17.39	324.36	2.00	0.00	1.00	0.00
17.55	311.95	2.00	0.00	1.00	0.00	17.72	310.30	2.00	0.00	1.00	0.00
17.88	329.85	2.00	0.00	1.00	0.00	18.05	363.64	2.00	0.00	1.00	0.00
18.21	403.97	2.00	0.00	1.00	0.00	18.37	433.93	2.00	0.00	1.00	0.00
18.54	439.86	2.00	0.00	1.00	0.00	18.70	417.99	2.00	0.00	1.00	0.00
18.87	369.86	2.00	0.00	1.00	0.00	19.03	300.06	2.00	0.00	1.00	0.00
19.19	238.32	2.00	0.00	1.00	0.00	19.36	186.17	0.45	1.40	1.00	0.03
19.52	168.92	0.35	1.52	1.00	0.03	19.69	163.97	0.32	1.56	1.00	0.03
19.85	153.47	0.27	1.64	1.00	0.03	20.01	163.91	0.32	1.56	1.00	0.03
20.18	174.40	0.38	1.48	1.00	0.03	20.34	181.91	0.42	1.43	1.00	0.03
20.51	192.04	0.48	1.37	1.00	0.03	20.67	206.32	2.00	0.00	1.00	0.00
20.83	218.08	2.00	0.00	1.00	0.00	21.00	230.16	2.00	0.00	1.00	0.00
21.16	224.62	2.00	0.00	1.00	0.00	21.33	225.33	2.00	0.00	1.00	0.00
21.49	234.30	2.00	0.00	1.00	0.00	21.65	260.02	2.00	0.00	1.00	0.00
21.82	284.93	2.00	0.00	1.00	0.00	21.98	308.85	2.00	0.00	1.00	0.00
22.15	330.18	2.00	0.00	1.00	0.00	22.31	343.95	2.00	0.00	1.00	0.00
22.47	352.97	2.00	0.00	1.00	0.00	22.64	358.14	2.00	0.00	1.00	0.00
22.80	361.36	2.00	0.00	1.00	0.00	22.97	360.71	2.00	0.00	1.00	0.00
23.13	355.97	2.00	0.00	1.00	0.00	23.30	344.93	2.00	0.00	1.00	0.00
23.46	328.92	2.00	0.00	1.00	0.00	23.62	316.02	2.00	0.00	1.00	0.00
23.79	310.58	2.00	0.00	1.00	0.00	23.95	315.53	2.00	0.00	1.00	0.00
24.12	324.57	2.00	0.00	1.00	0.00	24.28	333.30	2.00	0.00	1.00	0.00
24.44	334.35	2.00	0.00	1.00	0.00	24.61	323.34	2.00	0.00	1.00	0.00
24.77	298.44	2.00	0.00	1.00	0.00	24.94	254.99	2.00	0.00	1.00	0.00

:: Post-earthquake settlement due to soil liquefaction :: (continued)											
Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)
25.10	209.06	2.00	0.00	1.00	0.00	25.26	163.27	0.31	1.56	1.00	0.03
25.43	120.57	0.16	2.00	1.00	0.04	25.59	111.87	0.14	2.13	1.00	0.04
25.76	111.05	0.13	2.14	1.00	0.04	25.92	127.07	0.17	1.92	1.00	0.04
26.08	137.90	0.21	1.80	1.00	0.03	26.25	160.99	0.30	1.58	1.00	0.03
26.41	194.03	0.49	1.36	1.00	0.03	26.58	252.27	2.00	0.00	1.00	0.00
26.74	307.97	2.00	0.00	1.00	0.00	26.90	337.71	2.00	0.00	1.00	0.00
27.07	320.92	2.00	0.00	1.00	0.00	27.23	276.36	2.00	0.00	1.00	0.00
27.40	218.20	2.00	0.00	1.00	0.00	27.56	158.63	0.29	1.60	1.00	0.03
27.72	116.80	0.15	2.06	1.00	0.04	27.89	110.53	0.13	2.15	1.00	0.04
28.05	126.09	0.17	1.93	1.00	0.04	28.22	153.72	0.27	1.64	1.00	0.03
28.38	190.20	0.46	1.38	1.00	0.03	28.54	197.14	0.51	1.34	1.00	0.03
28.71	188.64	0.45	1.39	1.00	0.03	28.87	166.19	0.33	1.54	1.00	0.03
29.04	152.98	0.26	1.65	1.00	0.03	29.20	143.21	0.23	1.74	1.00	0.03
29.36	151.50	0.26	1.66	1.00	0.03	29.53	191.98	0.47	1.37	1.00	0.03
29.69	248.61	2.00	0.00	1.00	0.00	29.86	291.65	2.00	0.00	1.00	0.00
30.02	317.00	2.00	0.00	1.00	0.00	30.19	324.47	2.00	0.00	1.00	0.00
30.35	312.71	2.00	0.00	1.00	0.00	30.51	274.95	2.00	0.00	1.00	0.00
30.68	222.80	2.00	0.00	1.00	0.00	30.84	168.20	2.00	0.00	1.00	0.00
31.01	114.65	2.00	0.00	1.00	0.00	31.17	89.13	2.00	0.00	1.00	0.00
31.33	155.88	2.00	0.00	1.00	0.00	31.50	115.13	2.00	0.00	1.00	0.00
31.66	125.35	2.00	0.00	1.00	0.00	31.83	130.44	2.00	0.00	1.00	0.00
31.99	143.90	2.00	0.00	1.00	0.00	32.15	164.53	2.00	0.00	1.00	0.00
32.32	184.26	0.43	1.42	1.00	0.03	32.48	201.51	2.00	0.00	1.00	0.00
32.65	220.17	2.00	0.00	1.00	0.00	32.81	243.29	2.00	0.00	1.00	0.00
32.97	260.79	2.00	0.00	1.00	0.00	33.14	267.19	2.00	0.00	1.00	0.00
33.30	264.08	2.00	0.00	1.00	0.00	33.47	260.83	2.00	0.00	1.00	0.00
33.63	257.58	2.00	0.00	1.00	0.00	33.79	255.78	2.00	0.00	1.00	0.00
33.96	261.81	2.00	0.00	1.00	0.00	34.12	265.19	2.00	0.00	1.00	0.00
34.29	267.85	2.00	0.00	1.00	0.00	34.45	258.55	2.00	0.00	1.00	0.00
34.61	250.10	2.00	0.00	1.00	0.00	34.78	245.58	2.00	0.00	1.00	0.00
34.94	248.53	2.00	0.00	1.00	0.00	35.11	257.02	2.00	0.00	1.00	0.00
35.27	265.11	2.00	0.00	1.00	0.00	35.43	278.45	2.00	0.00	1.00	0.00
35.60	298.93	2.00	0.00	1.00	0.00	35.76	321.04	2.00	0.00	1.00	0.00
35.93	336.50	2.00	0.00	1.00	0.00	36.09	339.63	2.00	0.00	1.00	0.00
36.26	330.31	2.00	0.00	1.00	0.00	36.42	309.57	2.00	0.00	1.00	0.00
36.58	278.78	2.00	0.00	1.00	0.00	36.75	241.15	2.00	0.00	1.00	0.00
36.91	204.35	2.00	0.00	1.00	0.00	37.08	211.19	2.00	0.00	1.00	0.00
37.24	223.43	2.00	0.00	1.00	0.00	37.40	278.01	2.00	0.00	1.00	0.00
37.57	338.46	2.00	0.00	1.00	0.00	37.73	380.44	2.00	0.00	1.00	0.00
37.90	401.40	2.00	0.00	1.00	0.00	38.06	402.38	2.00	0.00	1.00	0.00
38.22	391.93	2.00	0.00	1.00	0.00	38.39	375.50	2.00	0.00	1.00	0.00
38.55	358.04	2.00	0.00	1.00	0.00	38.72	342.08	2.00	0.00	1.00	0.00
38.88	331.62	2.00	0.00	1.00	0.00	39.04	321.84	2.00	0.00	1.00	0.00
39.21	316.68	2.00	0.00	1.00	0.00	39.37	315.32	2.00	0.00	1.00	0.00
39.54	319.41	2.00	0.00	1.00	0.00	39.70	325.21	2.00	0.00	1.00	0.00
39.86	329.52	2.00	0.00	1.00	0.00	40.03	338.34	2.00	0.00	1.00	0.00
40.19	350.87	2.00	0.00	1.00	0.00	40.36	363.84	2.00	0.00	1.00	0.00
40.52	378.67	2.00	0.00	1.00	0.00	40.68	383.84	2.00	0.00	1.00	0.00

:: Post-earthquake settlement due to soil liquefaction :: (continued)											
Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)
40.85	393.16	2.00	0.00	1.00	0.00	41.01	395.15	2.00	0.00	1.00	0.00
41.18	393.68	2.00	0.00	1.00	0.00	41.34	381.92	2.00	0.00	1.00	0.00
41.50	368.69	2.00	0.00	1.00	0.00	41.67	346.49	2.00	0.00	1.00	0.00
41.83	316.81	2.00	0.00	1.00	0.00	42.00	273.34	2.00	0.00	1.00	0.00
42.16	221.83	2.00	0.00	1.00	0.00	42.32	172.40	2.00	0.00	1.00	0.00
42.49	137.47	2.00	0.00	1.00	0.00	42.65	115.44	2.00	0.00	1.00	0.00
42.82	102.56	2.00	0.00	1.00	0.00	42.98	110.12	0.14	2.16	1.00	0.04
43.15	192.04	0.51	1.37	1.00	0.03	43.31	83.41	0.55	0.50	1.00	0.01
43.47	80.97	0.47	0.50	1.00	0.01	43.64	80.92	0.46	0.50	1.00	0.01
43.80	83.67	0.50	0.50	1.00	0.01	43.97	84.81	0.53	0.50	1.00	0.01
44.13	86.03	0.54	0.50	1.00	0.01	44.29	84.49	0.54	0.50	1.00	0.01
44.46	86.15	0.51	0.50	1.00	0.01	44.62	86.12	0.50	0.50	1.00	0.01
44.79	85.94	0.51	0.50	1.00	0.01	44.95	85.53	0.54	0.50	1.00	0.01
45.11	85.34	0.55	0.50	1.00	0.01	45.28	85.29	0.55	0.50	1.00	0.01
45.44	83.76	0.54	0.50	1.00	0.01	45.61	80.73	0.53	0.50	1.00	0.01
45.77	77.60	0.53	0.50	1.00	0.01	45.93	76.04	0.51	0.50	1.00	0.01
46.10	74.46	0.50	0.50	1.00	0.01	46.26	71.14	0.48	0.50	1.00	0.01
46.43	67.67	0.47	0.50	1.00	0.01	46.59	65.93	0.45	0.50	1.00	0.01
46.75	64.10	0.44	0.50	1.00	0.01	46.92	62.12	0.43	0.50	1.00	0.01
47.08	60.12	0.43	0.50	1.00	0.01	47.25	60.18	0.41	0.50	1.00	0.01
47.41	58.25	0.39	0.50	1.00	0.01	47.57	56.18	0.36	0.50	1.00	0.01
47.74	56.23	0.35	0.50	1.00	0.01	47.90	64.21	0.33	0.50	1.00	0.01
48.07	82.56	0.34	0.50	1.00	0.01	48.23	107.85	2.00	0.00	1.00	0.00
48.39	125.97	2.00	0.00	1.00	0.00	48.56	145.96	2.00	0.00	1.00	0.00
48.72	168.29	2.00	0.00	1.00	0.00	48.89	174.70	0.42	1.48	1.00	0.03
49.05	169.69	0.39	1.51	1.00	0.03	49.22	161.30	0.35	1.58	1.00	0.03
49.38	174.25	0.42	1.48	1.00	0.03	49.54	199.35	0.60	1.12	1.00	0.02

Total estimated settlement: 1.71

Abbreviations

- $Q_{tn,cs}$: Equivalent clean sand normalized cone resistance
- FS: Factor of safety against liquefaction
- e_v (%): Post-liquefaction volumetric strain
- DF: e_v depth weighting factor
- Settlement: Calculated settlement

:: Strength loss calculation (Robertson (2009)) ::							
Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
0.33	181.37	342.77	1.00	342.77	1.43	N/A	N/A
0.49	197.20	372.68	1.00	372.68	1.45	N/A	N/A
0.66	206.87	390.93	1.00	390.93	1.48	N/A	N/A
0.82	194.07	366.72	1.00	366.72	1.54	N/A	N/A
0.98	169.30	319.89	1.00	319.89	1.58	N/A	N/A
1.15	149.80	283.01	1.00	283.01	1.60	N/A	N/A
1.31	138.40	261.44	1.00	261.44	1.57	N/A	N/A
1.48	132.53	250.33	1.00	250.33	1.58	N/A	N/A
1.64	126.23	238.41	1.02	242.85	1.67	N/A	N/A
1.80	122.80	231.90	1.07	249.04	1.75	N/A	N/A
1.97	116.20	219.40	1.10	240.79	1.79	N/A	N/A
2.13	104.53	197.33	1.09	214.41	1.77	N/A	N/A
2.30	91.43	172.55	1.06	182.60	1.73	N/A	N/A
2.46	83.56	157.66	1.06	167.62	1.74	N/A	N/A
2.62	88.73	167.41	1.05	175.25	1.71	N/A	N/A
2.79	105.33	198.77	1.01	200.07	1.65	N/A	N/A
2.95	128.13	241.85	1.00	241.85	1.59	N/A	N/A
3.12	152.93	288.70	1.00	288.70	1.52	N/A	N/A
3.28	173.37	326.78	1.00	326.78	1.47	N/A	N/A
3.45	189.27	344.05	1.00	344.05	1.44	N/A	N/A
3.61	191.90	342.18	1.00	342.18	1.44	N/A	N/A
3.77	183.90	326.04	1.00	326.04	1.46	N/A	N/A
3.94	170.27	300.60	1.00	300.60	1.48	N/A	N/A
4.10	161.03	282.61	1.00	282.61	1.50	N/A	N/A
4.27	157.63	272.54	1.00	272.54	1.51	N/A	N/A
4.43	157.23	268.40	1.00	268.40	1.52	N/A	N/A
4.59	154.93	265.92	1.00	265.92	1.56	N/A	N/A
4.76	152.33	263.18	1.00	263.18	1.61	N/A	N/A
4.92	151.03	263.58	1.01	265.50	1.66	N/A	N/A
5.09	171.13	289.55	1.00	289.55	1.62	0.99	0.99
5.25	207.52	337.89	1.00	337.89	1.55	1.01	1.01
5.41	255.05	400.40	1.00	400.40	1.49	1.04	1.04
5.58	290.49	445.48	1.00	445.48	1.45	1.06	1.06
5.74	311.59	471.07	1.00	471.07	1.43	1.07	1.07
5.91	293.20	447.53	1.00	447.53	1.47	1.06	1.06
6.07	238.46	379.49	1.00	379.49	1.58	1.03	1.03
6.23	155.92	269.72	1.11	298.55	1.80	0.98	0.98
6.40	91.94	173.02	1.37	237.23	2.05	0.91	0.91
6.56	54.08	101.43	2.03	205.87	2.32	0.83	0.83
6.73	40.21	75.21	2.55	191.87	2.45	0.79	0.79
6.89	37.72	70.48	2.49	175.40	2.44	0.78	0.78
7.05	43.89	82.12	1.82	149.49	2.26	0.80	0.80
7.22	56.78	101.71	1.32	134.66	2.02	0.83	0.83
7.38	71.21	118.84	1.15	136.10	1.85	0.85	0.85
7.55	84.15	134.96	1.08	145.62	1.76	0.87	0.87
7.71	96.93	152.80	1.06	161.62	1.73	0.89	0.89
7.87	112.03	173.72	1.04	180.24	1.70	0.91	0.91
8.04	130.16	198.38	1.02	201.55	1.67	0.93	0.93

:: Strength loss calculation (Robertson (2009)) :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
8.20	153.27	226.24	1.00	226.24	1.59	0.95	0.95
8.37	181.77	262.00	1.00	262.00	1.54	0.97	0.97
8.53	216.44	306.54	1.00	306.54	1.51	1.00	1.00
8.69	248.21	349.75	1.00	349.75	1.51	1.02	1.02
8.86	271.31	380.51	1.00	380.51	1.51	1.03	1.03
9.02	288.21	400.81	1.00	400.81	1.50	1.04	1.04
9.19	309.21	424.35	1.00	424.35	1.48	1.05	1.05
9.35	339.72	457.22	1.00	457.22	1.43	1.07	1.07
9.51	384.25	500.68	1.00	500.68	1.35	1.08	1.08
9.68	430.92	548.51	1.00	548.51	1.29	1.10	1.10
9.84	432.16	550.17	1.00	550.17	1.30	1.10	1.10
10.01	387.29	506.01	1.00	506.01	1.40	1.09	1.09
10.17	321.69	430.42	1.00	430.42	1.50	1.06	1.06
10.34	288.85	386.65	1.00	386.65	1.52	1.04	1.04
10.50	283.44	374.58	1.00	374.58	1.49	1.03	1.03
10.66	290.08	377.96	1.00	377.96	1.46	1.03	1.03
10.83	279.98	363.41	1.00	363.41	1.46	1.03	1.03
10.99	249.24	323.75	1.00	323.75	1.48	1.01	1.01
11.16	200.04	265.29	1.00	265.29	1.57	0.97	0.97
11.32	146.80	202.50	1.07	215.68	1.74	0.93	0.93
11.48	118.26	166.02	1.13	187.35	1.83	0.90	0.90
11.65	105.96	147.88	1.13	167.07	1.83	0.88	0.88
11.81	109.20	148.42	1.07	158.83	1.75	0.88	0.88
11.98	106.34	145.71	1.11	161.22	1.80	0.88	0.88
12.14	120.48	163.13	1.08	176.96	1.77	0.90	0.90
12.30	143.02	189.94	1.04	198.10	1.71	0.92	0.92
12.47	156.95	206.16	1.03	211.38	1.68	0.93	0.93
12.63	151.14	200.96	1.07	215.55	1.75	0.93	0.93
12.80	146.64	196.04	1.10	216.50	1.80	0.93	0.93
12.96	154.78	204.24	1.08	220.53	1.76	0.93	0.93
13.12	167.54	216.48	1.03	223.29	1.69	0.94	0.94
13.29	177.87	225.55	1.00	225.55	1.63	0.95	0.95
13.45	183.67	230.41	1.00	230.41	1.60	0.95	0.95
13.62	183.17	229.53	1.00	229.53	1.61	0.95	0.95
13.78	183.47	231.50	1.01	234.69	1.66	0.95	0.95
13.94	188.44	238.53	1.04	247.53	1.70	0.96	0.96
14.11	201.04	250.89	1.01	252.47	1.65	0.97	0.97
14.27	205.57	255.57	1.01	257.57	1.66	0.97	0.97
14.44	181.10	228.06	1.07	243.57	1.74	0.95	0.95
14.60	131.30	171.78	1.26	216.28	1.97	0.91	0.91
14.76	79.22	108.13	1.74	188.62	2.23	0.84	0.84
14.93	48.32	68.31	2.68	182.94	2.48	0.78	0.78
15.09	44.20	62.05	2.71	168.45	2.49	0.76	0.76
15.26	61.94	83.07	1.80	149.28	2.25	0.80	0.80
15.42	92.27	117.41	1.26	148.14	1.97	0.85	0.85
15.58	131.07	159.53	1.06	169.32	1.73	0.90	0.90
15.75	172.37	204.19	1.00	204.19	1.60	0.93	0.93
15.91	215.60	251.34	1.00	251.34	1.52	0.97	0.97

:: Strength loss calculation (Robertson (2009)) :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
16.08	251.50	291.21	1.00	291.21	1.50	0.99	0.99
16.24	275.77	318.06	1.00	318.06	1.50	1.00	1.00
16.40	290.97	334.24	1.00	334.24	1.49	1.01	1.01
16.57	300.10	343.68	1.00	343.68	1.50	1.02	1.02
16.73	305.20	348.91	1.00	348.91	1.51	1.02	1.02
16.90	307.50	350.86	1.00	350.86	1.52	1.02	1.02
17.06	306.24	348.53	1.00	348.53	1.53	1.02	1.02
17.23	298.30	339.02	1.00	339.02	1.54	1.02	1.02
17.39	284.83	324.36	1.00	324.36	1.58	1.01	1.01
17.55	272.87	311.95	1.00	311.95	1.64	1.00	1.00
17.72	272.30	310.41	1.00	310.30	1.64	1.00	1.00
17.88	292.33	329.85	1.00	329.85	1.60	1.01	1.01
18.05	325.94	363.64	1.00	363.64	1.54	1.03	1.03
18.21	364.91	403.97	1.00	403.97	1.51	1.05	1.05
18.37	394.01	433.93	1.00	433.93	1.49	1.06	1.06
18.54	401.35	439.86	1.00	439.86	1.48	1.06	1.06
18.70	382.61	417.99	1.00	417.99	1.48	1.05	1.05
18.87	338.14	369.86	1.00	369.86	1.53	1.03	1.03
19.03	272.27	300.06	1.00	300.06	1.63	0.99	0.99
19.19	192.49	215.32	1.11	238.32	1.80	0.94	0.94
19.36	116.99	133.72	1.39	186.17	2.06	0.87	0.87
19.52	67.09	78.29	2.16	168.92	2.36	0.79	0.79
19.69	62.17	72.27	2.27	163.97	2.39	0.78	0.78
19.85	91.29	103.25	1.49	153.47	2.12	0.83	0.83
20.01	131.05	144.02	1.14	163.91	1.84	0.88	0.88
20.18	155.64	168.19	1.04	174.40	1.70	0.90	0.90
20.34	163.97	176.51	1.03	181.91	1.69	0.91	0.91
20.51	171.06	183.92	1.04	192.04	1.71	0.92	0.92
20.67	184.03	197.32	1.05	206.32	1.71	0.93	0.93
20.83	194.82	208.30	1.05	218.08	1.71	0.94	0.94
21.00	203.15	216.87	1.06	230.16	1.73	0.94	0.94
21.16	203.55	215.95	1.04	224.62	1.70	0.94	0.94
21.33	209.68	221.13	1.02	225.33	1.67	0.95	0.95
21.49	223.48	234.46	1.00	234.30	1.64	0.95	0.95
21.65	245.31	257.01	1.01	260.02	1.66	0.97	0.97
21.82	272.88	284.70	1.00	284.93	1.65	0.99	0.99
21.98	297.58	308.85	1.00	308.85	1.62	1.00	1.00
22.15	319.58	330.18	1.00	330.18	1.60	1.01	1.01
22.31	334.31	343.95	1.00	343.95	1.58	1.02	1.02
22.47	344.75	352.97	1.00	352.97	1.55	1.02	1.02
22.64	351.51	358.14	1.00	358.14	1.53	1.02	1.02
22.80	355.95	361.36	1.00	361.36	1.52	1.03	1.03
22.97	356.21	360.71	1.00	360.71	1.53	1.03	1.03
23.13	352.44	355.97	1.00	355.97	1.53	1.02	1.02
23.30	342.61	344.93	1.00	344.93	1.53	1.02	1.02
23.46	327.54	328.92	1.00	328.92	1.55	1.01	1.01
23.62	315.14	316.02	1.00	316.02	1.58	1.00	1.00
23.79	310.08	310.58	1.00	310.58	1.63	1.00	1.00

:: Strength loss calculation (Robertson (2009)) :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
23.95	315.65	315.46	1.00	315.53	1.65	1.00	1.00
24.12	326.65	324.57	1.00	324.57	1.58	1.01	1.01
24.28	337.11	333.30	1.00	333.30	1.53	1.01	1.01
24.44	339.58	334.35	1.00	334.35	1.49	1.01	1.01
24.61	329.12	323.34	1.00	323.34	1.52	1.01	1.01
24.77	304.59	298.44	1.00	298.44	1.53	0.99	0.99
24.94	260.48	254.99	1.00	254.99	1.62	0.97	0.97
25.10	196.71	192.46	1.09	209.06	1.77	0.92	0.92
25.26	132.64	129.53	1.26	163.27	1.97	0.86	0.86
25.43	83.35	80.82	1.49	120.57	2.12	0.80	0.80
25.59	56.92	54.75	2.04	111.87	2.33	0.75	0.75
25.76	50.20	47.97	2.32	111.05	2.40	0.73	0.73
25.92	61.74	59.08	2.15	127.07	2.36	0.76	0.76
26.08	80.44	77.01	1.79	137.90	2.25	0.79	0.79
26.25	103.18	98.72	1.63	160.99	2.19	0.83	0.83
26.41	159.12	152.12	1.28	194.03	1.98	0.89	0.89
26.58	243.59	232.31	1.09	252.27	1.77	0.95	0.95
26.74	323.78	307.97	1.00	307.97	1.63	1.00	1.00
26.90	356.01	337.71	1.00	337.71	1.59	1.01	1.01
27.07	339.37	320.92	1.00	320.92	1.62	1.01	1.01
27.23	293.80	276.84	1.00	276.36	1.64	0.98	0.98
27.40	231.69	217.34	1.00	218.20	1.65	0.94	0.94
27.56	168.08	156.82	1.01	158.63	1.66	0.89	0.89
27.72	111.25	102.92	1.13	116.80	1.84	0.83	0.83
27.89	69.59	63.43	1.74	110.53	2.23	0.77	0.77
28.05	85.93	78.47	1.61	126.09	2.17	0.79	0.79
28.22	137.47	126.34	1.22	153.72	1.93	0.86	0.86
28.38	195.54	180.24	1.06	190.20	1.73	0.91	0.91
28.54	208.03	191.42	1.03	197.14	1.69	0.92	0.92
28.71	188.59	172.65	1.09	188.64	1.78	0.91	0.91
28.87	148.12	134.48	1.24	166.19	1.95	0.87	0.87
29.04	106.86	95.83	1.60	152.98	2.17	0.82	0.82
29.20	89.50	79.58	1.80	143.21	2.25	0.80	0.80
29.36	129.27	115.90	1.31	151.50	2.01	0.85	0.85
29.53	199.51	180.31	1.06	191.98	1.74	0.91	0.91
29.69	274.01	248.61	1.00	248.61	1.58	0.96	0.96
29.86	321.38	291.65	1.00	291.65	1.51	0.99	0.99
30.02	349.58	317.00	1.00	317.00	1.47	1.00	1.00
30.19	358.25	324.47	1.00	324.47	1.44	1.01	1.01
30.35	346.34	312.71	1.00	312.71	1.46	1.00	1.00
30.51	306.60	274.95	1.00	274.95	1.57	0.98	0.98
30.68	236.40	209.74	1.06	222.80	1.74	0.94	0.94
30.84	159.56	139.65	1.20	168.20	1.92	0.88	0.88
31.01	94.59	81.32	1.41	114.65	2.07	0.80	0.80
31.17	56.70	47.50	1.88	89.13	2.28	0.73	0.73
31.33	34.87	28.06	3.35	94.05	2.60	1.98	1.98
31.50	36.01	28.79	4.00	115.13	2.70	2.04	2.04
31.66	58.12	47.82	2.62	125.35	2.47	0.73	0.73

:: Strength loss calculation (Robertson (2009)) :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
31.83	94.76	79.82	1.63	130.44	2.19	0.80	0.80
31.99	136.15	116.47	1.24	143.90	1.95	0.85	0.85
32.15	175.68	151.74	1.08	164.53	1.77	0.89	0.89
32.32	208.34	180.70	1.02	184.26	1.67	0.91	0.91
32.48	227.81	197.24	1.02	201.51	1.68	0.93	0.93
32.65	242.97	209.40	1.05	220.17	1.72	0.94	0.94
32.81	264.47	227.09	1.07	243.29	1.75	0.95	0.95
32.97	287.47	246.63	1.06	260.79	1.73	0.96	0.96
33.14	301.27	258.36	1.03	267.19	1.69	0.97	0.97
33.30	303.97	260.51	1.01	264.08	1.66	0.97	0.97
33.47	300.00	256.29	1.02	260.83	1.67	0.97	0.97
33.63	291.56	247.87	1.04	257.58	1.70	0.96	0.96
33.79	280.43	236.71	1.08	255.78	1.76	0.96	0.96
33.96	280.73	235.55	1.11	261.81	1.81	0.96	0.96
34.12	290.13	243.34	1.09	265.19	1.78	0.96	0.96
34.29	298.43	250.14	1.07	267.85	1.75	0.97	0.97
34.45	287.12	239.75	1.08	258.55	1.76	0.96	0.96
34.61	262.16	216.42	1.16	250.10	1.86	0.94	0.94
34.78	248.33	203.35	1.21	245.58	1.92	0.93	0.93
34.94	250.10	204.03	1.22	248.53	1.93	0.93	0.93
35.11	266.26	217.30	1.18	257.02	1.89	0.94	0.94
35.27	281.09	229.43	1.16	265.11	1.86	0.95	0.95
35.43	302.69	247.27	1.13	278.45	1.83	0.96	0.96
35.60	332.06	271.43	1.10	298.93	1.79	0.98	0.98
35.76	362.49	296.34	1.08	321.04	1.77	0.99	0.99
35.93	382.60	312.20	1.08	336.50	1.76	1.00	1.00
36.09	385.83	313.82	1.08	339.63	1.77	1.00	1.00
36.26	373.10	302.07	1.09	330.31	1.78	1.00	1.00
36.42	349.33	281.73	1.10	309.57	1.79	0.98	0.98
36.58	314.39	252.52	1.10	278.78	1.80	0.97	0.97
36.75	260.05	206.24	1.17	241.15	1.88	0.93	0.93
36.91	187.85	145.14	1.41	204.35	2.07	0.88	0.88
37.08	155.59	117.32	1.80	211.19	2.25	0.85	0.85
37.24	201.17	154.18	1.45	223.43	2.10	0.89	0.89
37.40	300.71	235.84	1.18	278.01	1.89	0.96	0.96
37.57	393.18	312.10	1.08	338.46	1.77	1.00	1.00
37.73	444.95	352.88	1.08	380.44	1.76	1.02	1.02
37.90	474.92	376.48	1.07	401.40	1.74	1.03	1.03
38.06	484.12	384.02	1.05	402.38	1.71	1.04	1.04
38.22	478.08	379.18	1.03	391.93	1.69	1.03	1.03
38.39	459.72	363.65	1.03	375.50	1.69	1.03	1.03
38.55	439.42	346.63	1.03	358.04	1.69	1.02	1.02
38.72	420.05	330.23	1.04	342.08	1.70	1.01	1.01
38.88	406.15	318.07	1.04	331.62	1.71	1.00	1.00
39.04	397.28	310.71	1.04	321.84	1.70	1.00	1.00
39.21	392.41	306.17	1.03	316.68	1.69	1.00	1.00
39.37	393.15	306.28	1.03	315.32	1.69	1.00	1.00
39.54	397.98	309.04	1.03	319.41	1.69	1.00	1.00

:: Strength loss calculation (Robertson (2009)) :: (continued)							
Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
39.70	407.99	316.45	1.03	325.21	1.69	1.00	1.00
39.86	419.66	325.79	1.01	329.52	1.66	1.01	1.01
40.03	434.49	337.01	1.00	338.34	1.65	1.01	1.01
40.19	451.72	350.87	1.00	350.87	1.62	1.02	1.02
40.36	469.62	363.84	1.00	363.84	1.63	1.03	1.03
40.52	488.66	378.67	1.00	378.67	1.61	1.03	1.03
40.68	497.92	383.84	1.00	383.84	1.63	1.04	1.04
40.85	511.29	393.16	1.00	393.16	1.63	1.04	1.04
41.01	513.59	393.05	1.01	395.15	1.65	1.04	1.04
41.18	515.26	393.84	1.00	393.68	1.64	1.04	1.04
41.34	500.02	381.92	1.00	381.92	1.63	1.04	1.04
41.50	482.19	368.69	1.00	368.69	1.61	1.03	1.03
41.67	452.88	346.49	1.00	346.49	1.59	1.02	1.02
41.83	414.34	316.81	1.00	316.81	1.57	1.00	1.00
42.00	359.84	273.34	1.00	273.34	1.60	0.98	0.98
42.16	286.83	213.54	1.04	221.83	1.70	0.94	0.94
42.32	201.19	144.22	1.20	172.40	1.91	0.88	0.88
42.49	124.61	84.66	1.62	137.47	2.18	0.80	0.80
42.65	76.68	49.46	2.33	115.44	2.41	0.73	0.73
42.82	56.29	35.14	2.80	98.37	2.51	0.69	0.69
42.98	45.94	28.07	3.04	85.27	2.55	0.66	0.66
43.15	37.25	21.91	3.82	83.79	2.68	1.53	1.53
43.31	29.67	16.65	5.01	83.41	2.83	1.19	1.19
43.47	25.67	14.13	5.73	80.97	2.90	1.01	1.01
43.64	25.43	13.93	5.81	80.92	2.91	1.00	1.00
43.80	27.03	14.88	5.62	83.67	2.89	1.06	1.06
43.97	28.55	15.76	5.38	84.81	2.87	1.13	1.13
44.13	29.45	16.26	5.29	86.03	2.86	1.16	1.16
44.29	29.25	16.09	5.25	84.49	2.85	1.15	1.15
44.46	27.78	15.14	5.69	86.15	2.90	1.08	1.08
44.62	27.36	14.84	5.80	86.12	2.91	1.06	1.06
44.79	27.89	15.12	5.68	85.94	2.90	1.08	1.08
44.95	29.63	16.12	5.31	85.53	2.86	1.15	1.15
45.11	30.10	16.35	5.22	85.34	2.85	1.17	1.17
45.28	29.92	16.19	5.27	85.29	2.85	1.16	1.16
45.44	29.76	16.05	5.22	83.76	2.85	1.15	1.15
45.61	29.37	15.77	5.12	80.73	2.84	1.13	1.13
45.77	28.99	15.49	5.01	77.60	2.83	1.11	1.11
45.93	28.38	15.09	5.04	76.04	2.83	1.08	1.08
46.10	27.73	14.66	5.08	74.46	2.83	1.05	1.05
46.26	27.08	14.23	5.00	71.14	2.82	1.02	1.02
46.43	26.34	13.75	4.92	67.67	2.82	0.29	0.98
46.59	25.48	13.21	4.99	65.93	2.82	0.29	0.94
46.75	24.82	12.79	5.01	64.10	2.83	0.29	0.91
46.92	24.64	12.64	4.91	62.12	2.81	0.23	0.90
47.08	24.30	12.41	4.84	60.12	2.81	0.23	0.89
47.25	23.60	11.97	5.03	60.18	2.83	0.23	0.85
47.41	22.34	11.21	5.20	58.25	2.85	0.23	0.80

:: Strength loss calculation (Robertson (2009)) :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
47.57	21.29	10.57	5.32	56.18	2.86	0.17	0.75
47.74	20.38	10.01	5.62	56.23	2.89	0.17	0.72
47.90	19.82	9.66	6.65	64.21	2.99	0.23	0.69
48.07	19.90	9.68	8.53	82.56	3.15	0.69	0.69
48.23	35.29	18.47	5.84	107.85	2.91	1.32	1.32
48.39	81.12	47.47	2.65	125.97	2.48	0.73	0.73
48.56	129.16	79.72	1.83	145.96	2.26	0.80	0.80
48.72	169.58	107.10	1.57	168.29	2.16	0.84	0.84
48.89	169.24	105.87	1.65	174.70	2.19	0.84	0.84
49.05	165.45	103.23	1.64	169.69	2.19	0.83	0.83
49.22	169.49	106.79	1.51	161.30	2.13	0.84	0.84
49.38	218.93	144.01	1.21	174.25	1.92	0.88	0.88
49.54	269.30	182.24	1.09	199.35	1.78	0.92	0.92

Abbreviations

q_t :	Total cone resistance
K_c :	Cone resistance correction factor due to fines
$Q_{tn,cs}$:	Adjusted and corrected cone resistance due to fines
I_c :	Soil behavior type index
$S_{u(liq)}/\sigma'_v$:	Calculated liquefied undrained strength ratio
$S_{u(peak)}/\sigma'_v$:	Calculated peak undrained strength ratio

LIQUEFACTION ANALYSIS REPORT

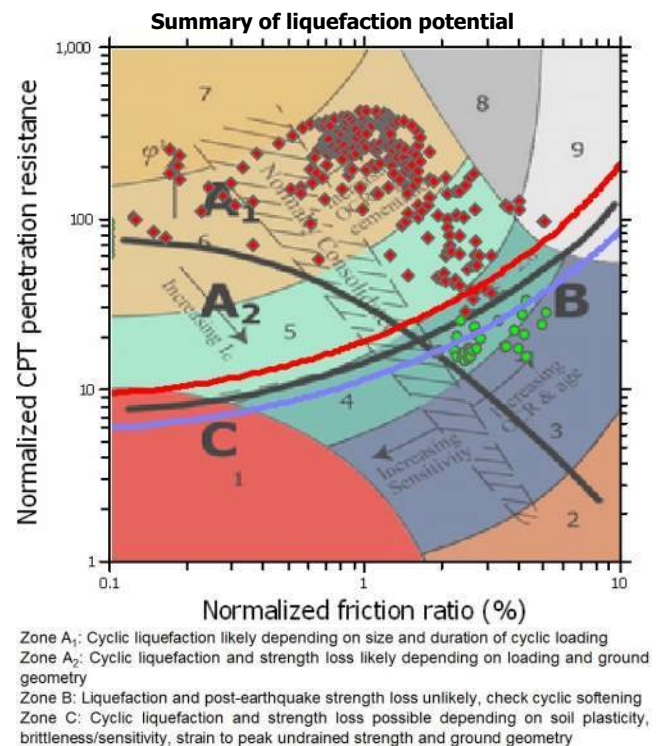
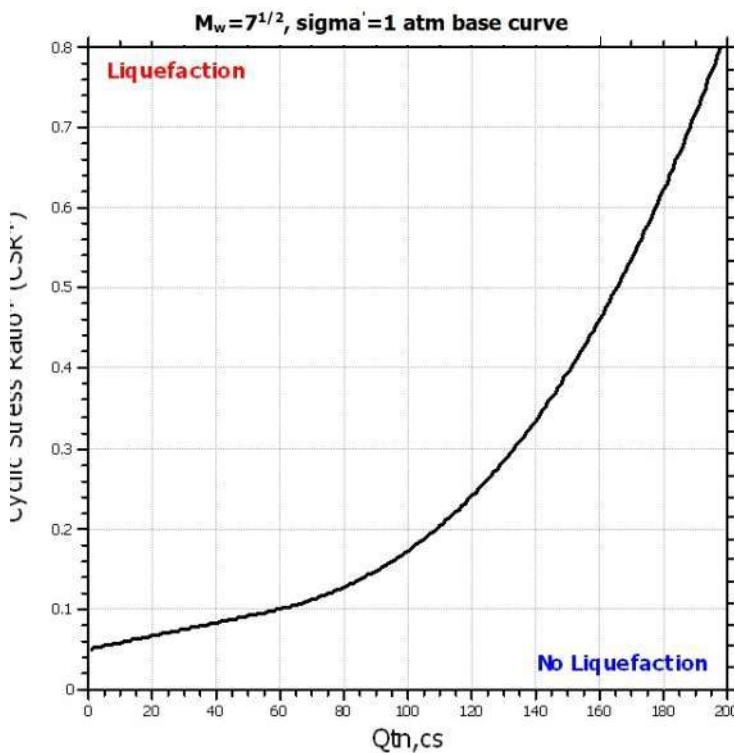
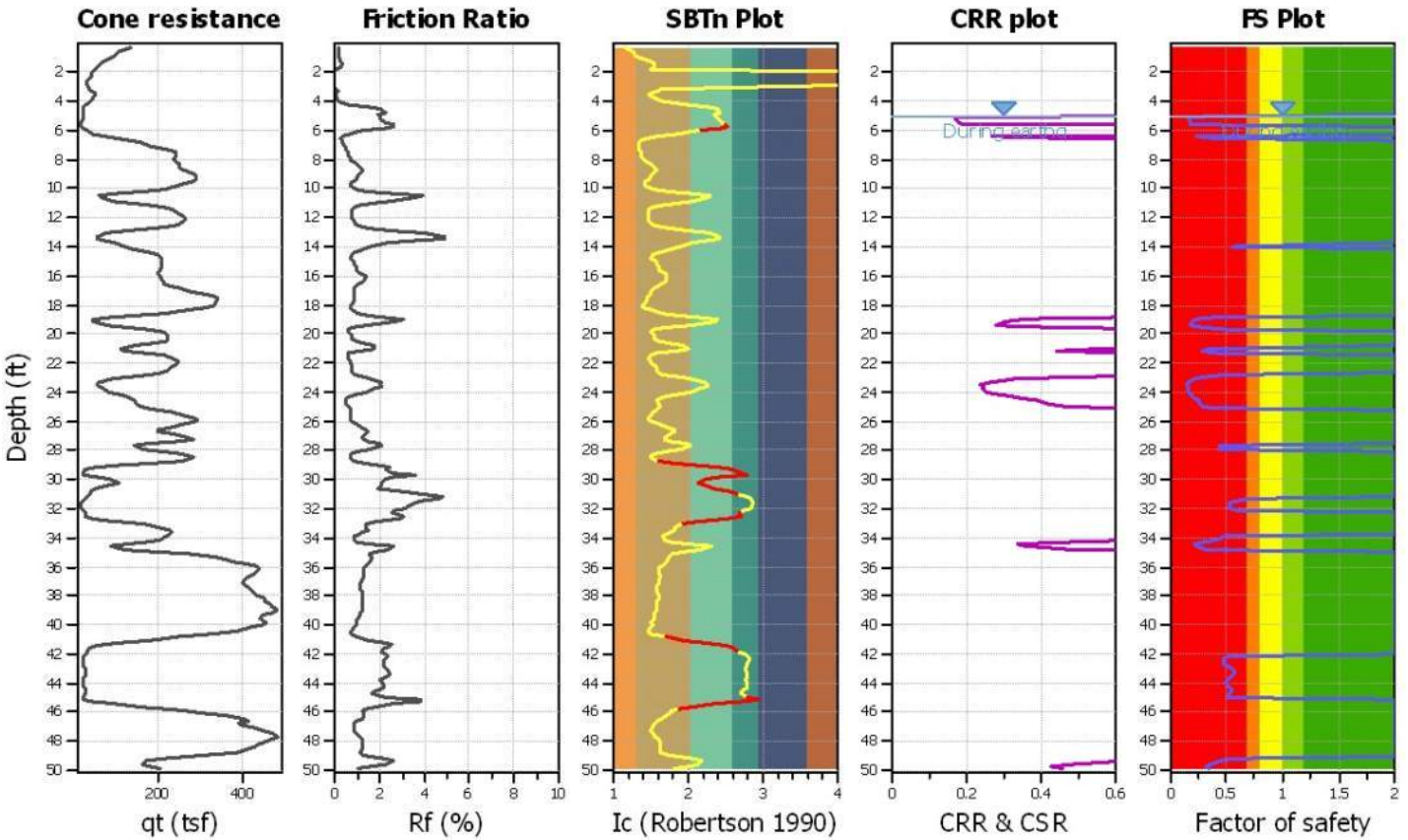
Project title :

Location :

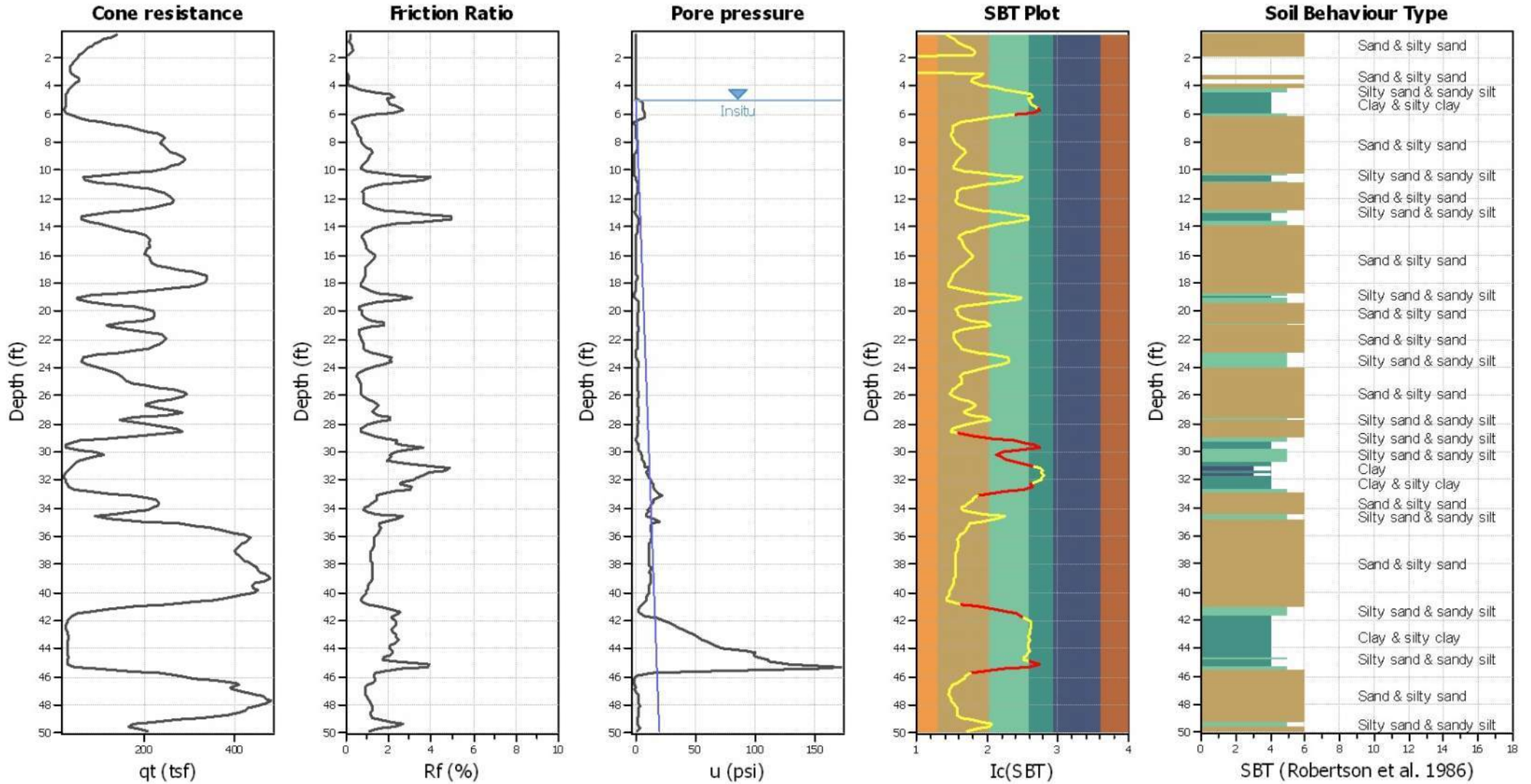
CPT file : CPT-03

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	5.00 ft	Use fill:	No	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	5.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w :	8.10	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	1.27	Unit weight calculation:	Based on SBT	K_0 applied:	No		



CPT basic interpretation plo



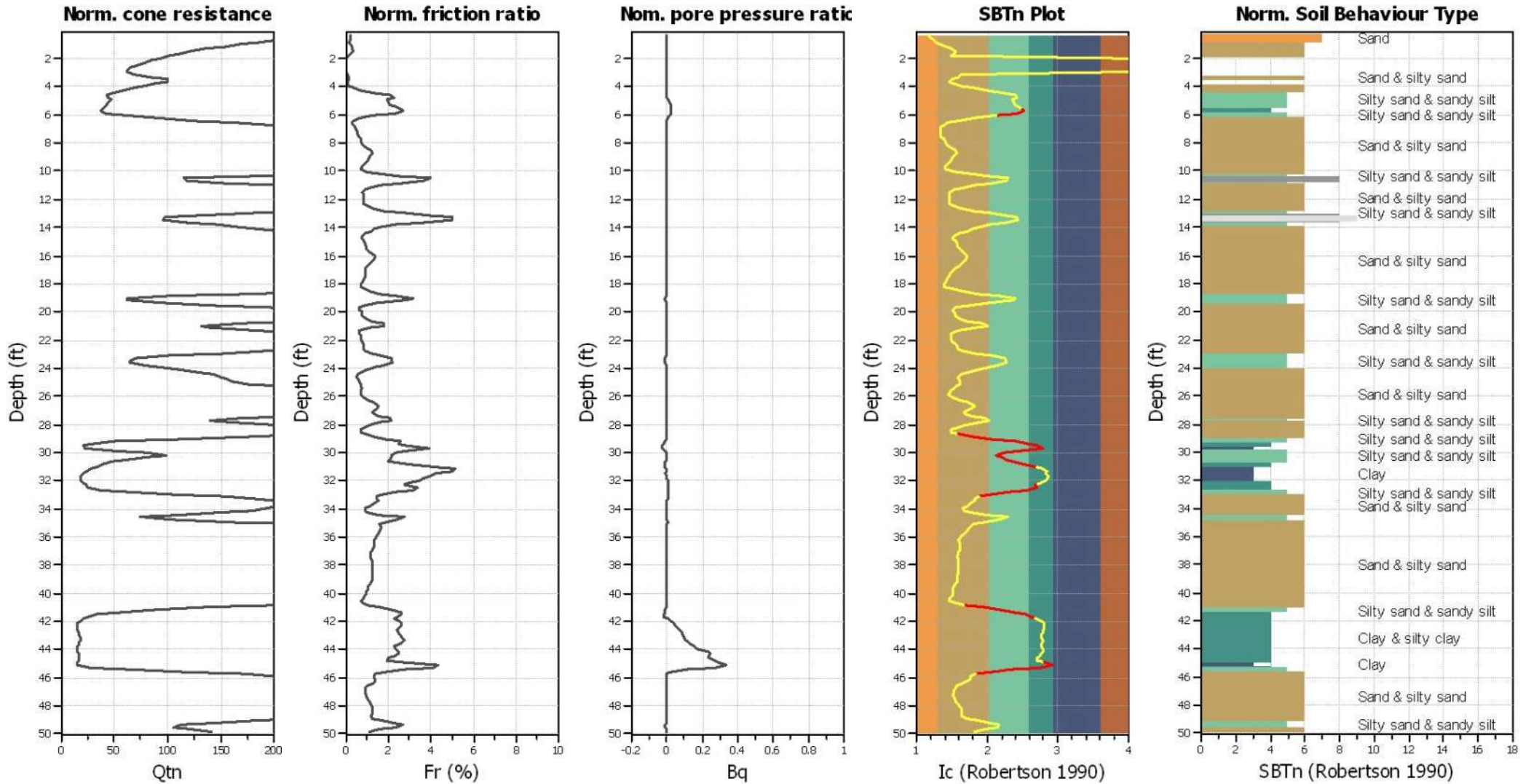
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	5.00 ft	Fill weight:	N/A
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _v applied:	No
Earthquake magnitude M _w :	8.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	1.27	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	5.00 ft	Fill height:	N/A	Limit depth:	N/A

SBT legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

CPT basic interpretation plots (normaliz



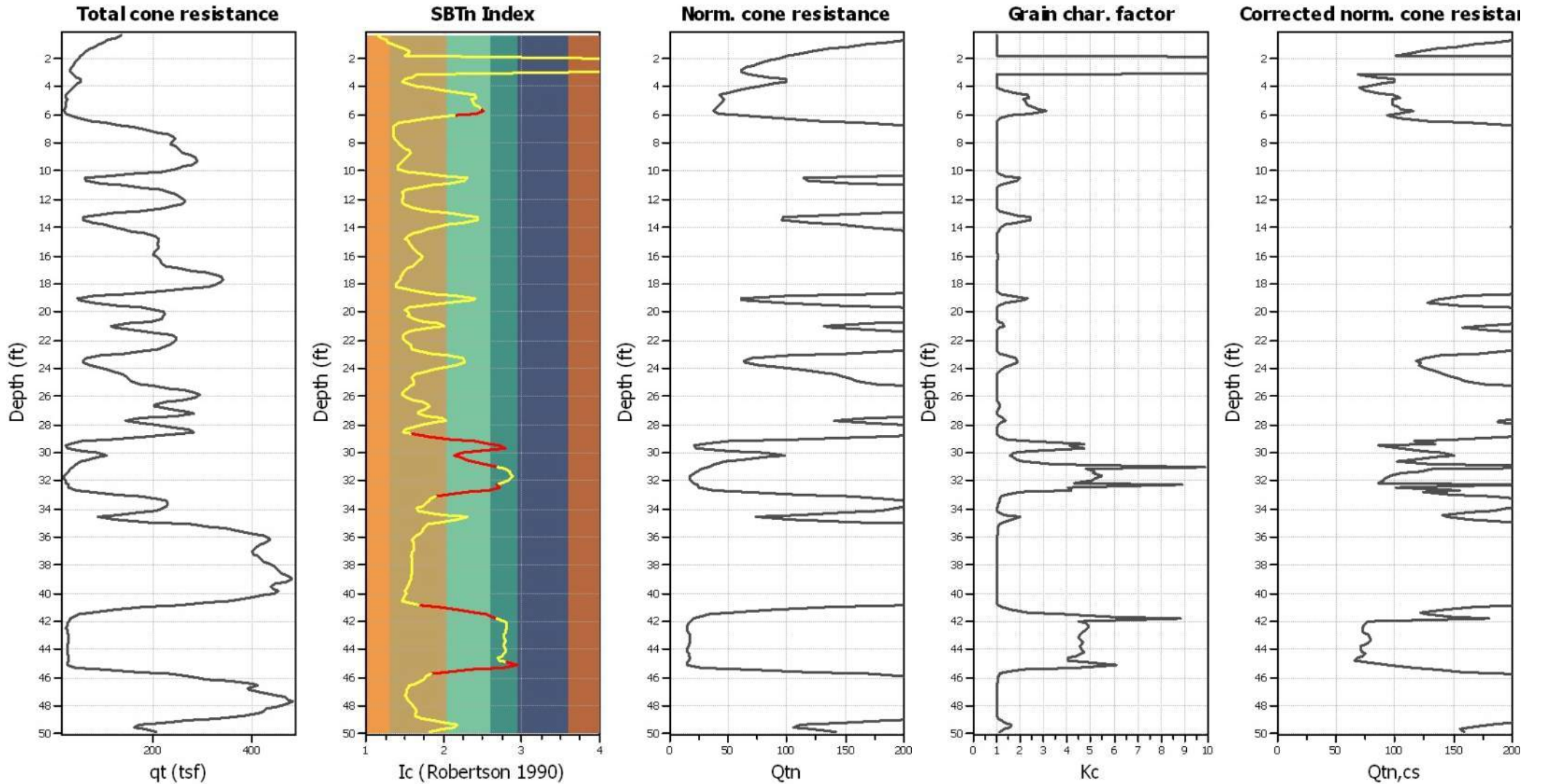
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	5.00 ft	Fill weight:	N/A
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _v applied:	No
Earthquake magnitude M _w :	8.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	1.27	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	5.00 ft	Fill height:	N/A	Limit depth:	N/A

SBTn legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

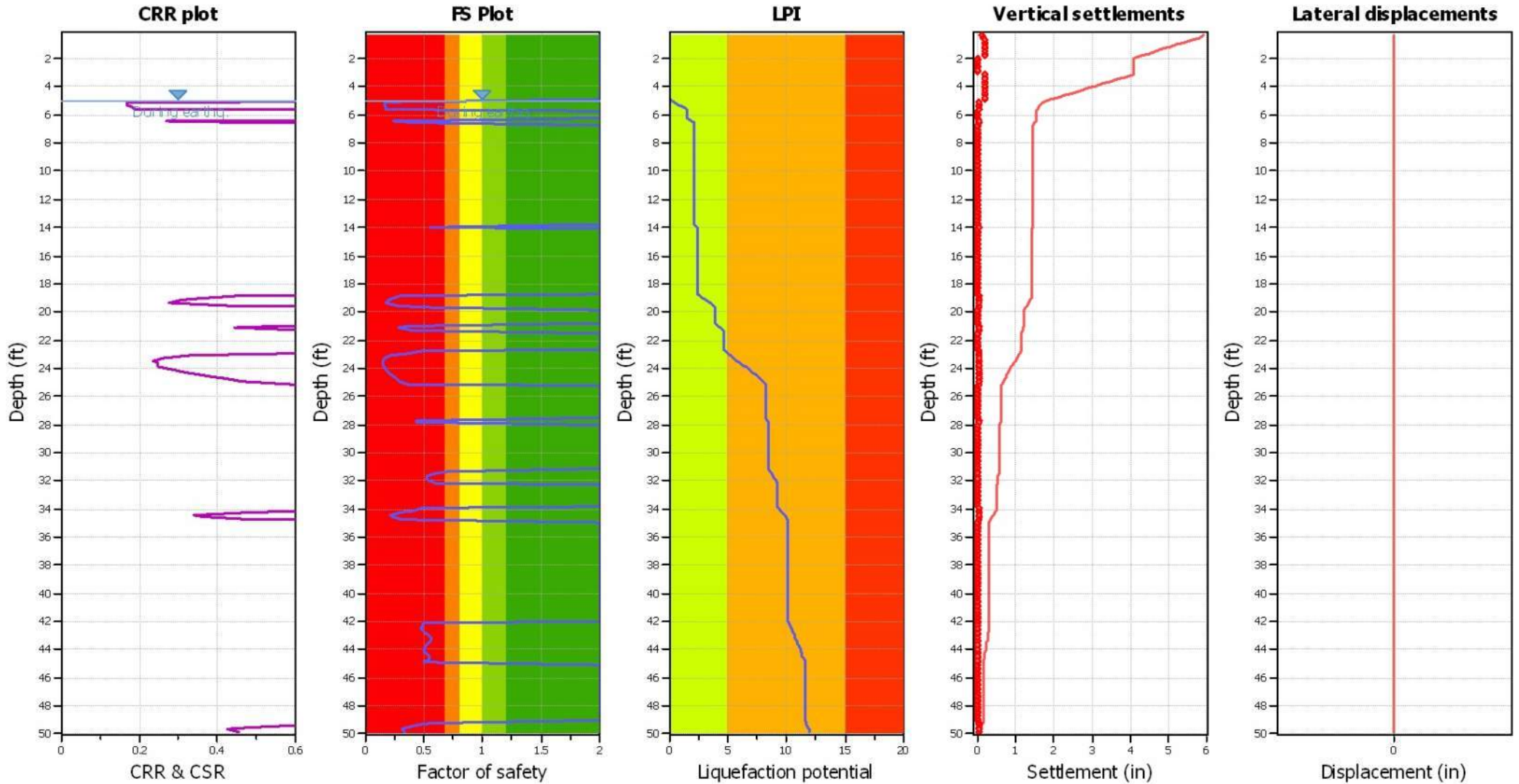
Liquefaction analysis overall plots (intermediate resu



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	5.00 ft	Fill weight:	N/A
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _v applied:	No
Earthquake magnitude M _w :	8.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	1.27	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	5.00 ft	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plot



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	5.00 ft	Fill weight:	N/A
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _v applied:	No
Earthquake magnitude M _w :	8.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	1.27	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	5.00 ft	Fill height:	N/A	Limit depth:	N/A

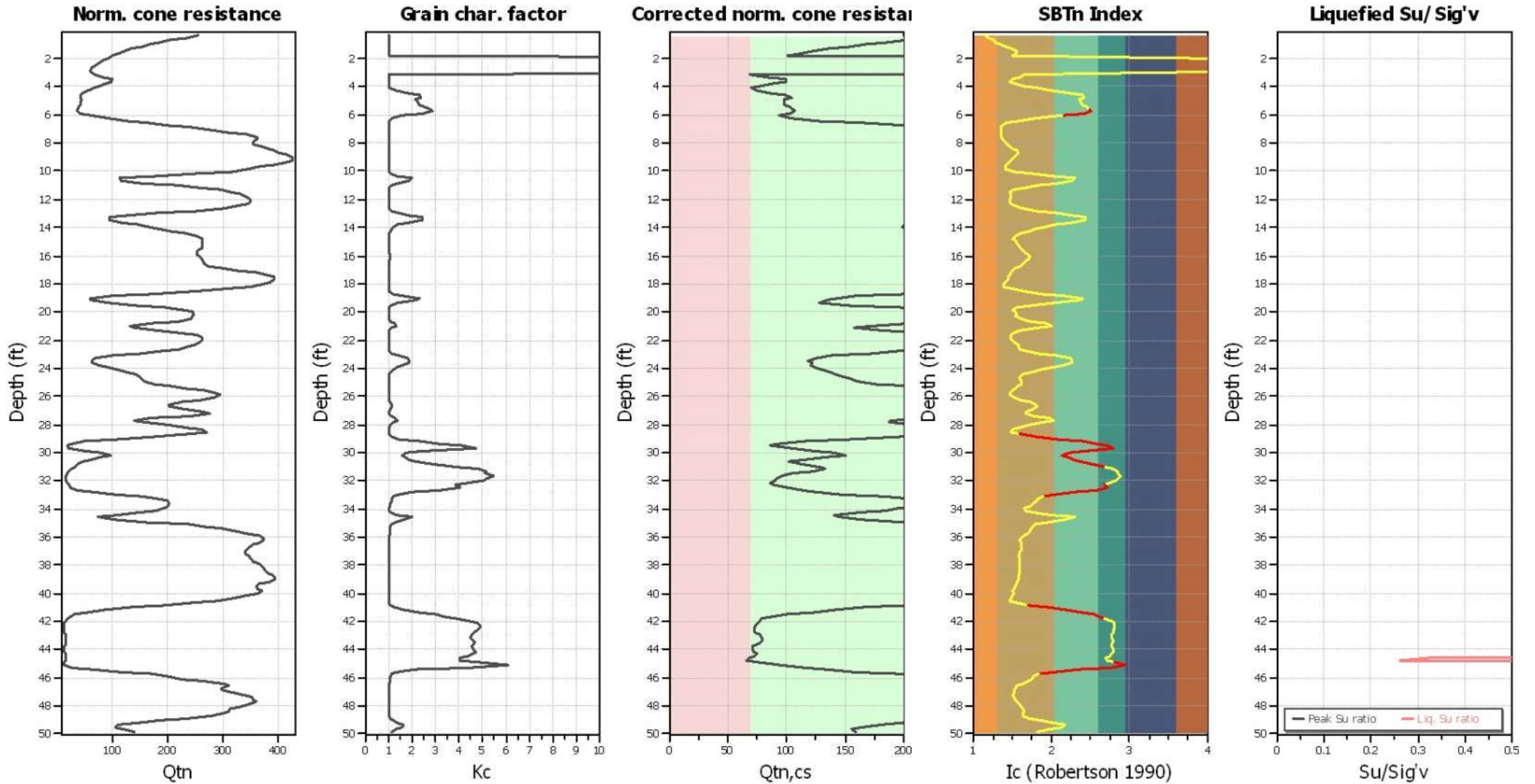
F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	5.00 ft	Fill weight:	N/A
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _c applied:	No
Earthquake magnitude M _w :	8.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	1.27	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	5.00 ft	Fill height:	N/A	Limit depth:	N/A

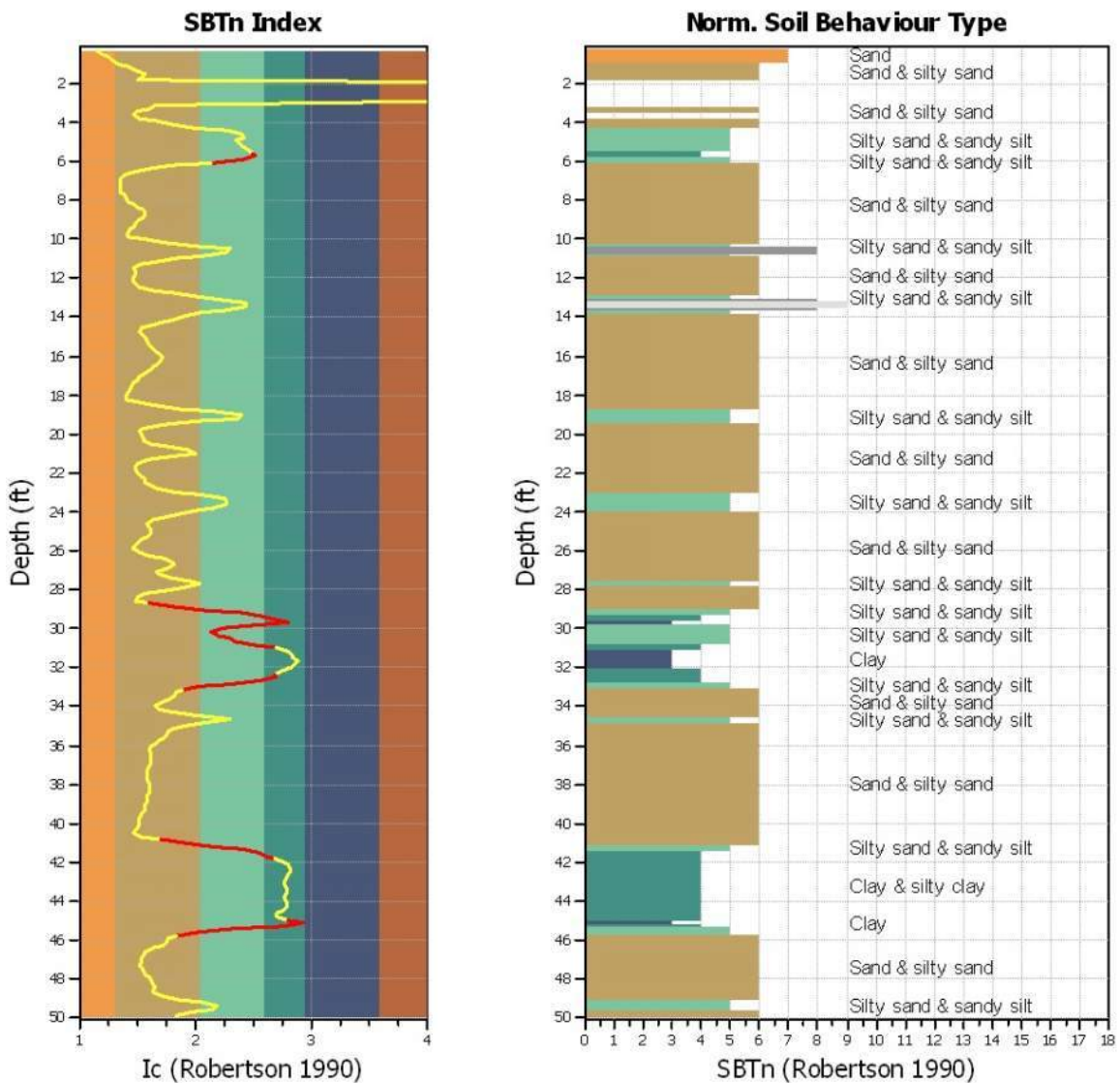
TRANSITION LAYER DETECTION ALGORITHM REPORT

Summary Details & Plots

Short description

The software will delete data when the cone is in transition from either clay to sand or vice-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between $1.80 < I_c < 3.0$) and a rate of change of I_c . Transitions typically occur when the rate of change of I_c is fast (i.e. ΔI_c is small).

The SBT_n plot below, displays in red the detected transition layers based on the parameters listed below the graphs.



Transition layer algorithm properties		General statistics	
I_c minimum check value:	1.70	Total points in CPT file:	303
I_c maximum check value:	3.00	Total points excluded:	40
I_c change ratio value:	0.0250	Exclusion percentage:	13.20%
Minimum number of points in layer:	4	Number of layers detected:	7

Transition layer No	Number of points	Depth	SBT _n number	SBT _n description
Transition layer 1	4	Start depth: 5.74 (ft)	4	Clay & silty clay
		End depth: 6.23 (ft)	6	Sand & silty sand
Transition layer 2	6	Start depth: 28.87 (ft)	6	Sand & silty sand
		End depth: 29.69 (ft)	3	Clay
Transition layer 3	4	Start depth: 29.69 (ft)	3	Clay
		End depth: 30.19 (ft)	5	Silty sand & sandy silt
Transition layer 4	7	Start depth: 30.19 (ft)	5	Silty sand & sandy silt
		End depth: 31.17 (ft)	3	Clay
Transition layer 5	6	Start depth: 32.48 (ft)	4	Clay & silty clay
		End depth: 33.30 (ft)	6	Sand & silty sand
Transition layer 6	7	Start depth: 41.01 (ft)	6	Sand & silty sand
		End depth: 42.00 (ft)	4	Clay & silty clay
Transition layer 7	6	Start depth: 45.11 (ft)	3	Clay
		End depth: 45.93 (ft)	6	Sand & silty sand

Start depth: Depth where the transition layer begins

End depth: Depth where the transition layer ends

:: Field input data ::						
Point ID	Depth (ft)	q _c (tsf)	f _s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
1	0.33	142.60	0.20	0.40	0.00	111.60
2	0.49	121.50	0.30	0.40	0.00	111.37
3	0.66	107.10	0.20	0.10	0.00	109.93
4	0.82	96.90	0.10	0.10	0.24	108.34
5	0.98	90.10	0.20	0.10	0.78	108.12
6	1.15	81.50	0.20	0.10	1.82	109.21
7	1.31	71.50	0.20	0.10	2.72	108.93
8	1.48	63.40	0.20	0.10	3.72	108.65
9	1.64	57.70	0.20	0.10	3.48	105.44
10	1.80	53.20	0.00	0.10	2.83	100.16
11	1.97	49.60	0.00	0.10	100.00	87.36
12	2.13	45.40	0.00	0.10	100.00	87.36
13	2.30	41.10	0.00	0.20	100.00	87.36
14	2.46	36.80	0.00	0.20	100.00	87.36
15	2.62	34.10	0.00	0.20	100.00	87.36
16	2.79	32.30	0.00	0.20	100.00	87.36
17	2.95	31.60	0.00	0.20	100.00	87.36
18	3.12	33.60	0.00	0.20	5.00	94.16
19	3.28	44.30	0.10	0.20	4.23	99.74
20	3.45	56.80	0.10	0.20	2.91	100.14
21	3.61	57.90	0.00	0.20	2.44	95.07
22	3.77	44.20	0.00	0.10	3.12	94.80
23	3.94	40.40	0.10	0.10	5.00	99.50
24	4.10	37.90	0.10	0.10	5.00	104.32
25	4.27	32.10	0.20	0.10	12.98	106.84
26	4.43	21.80	0.30	0.10	21.45	110.79
27	4.59	21.50	0.60	0.20	26.23	112.32
28	4.76	25.20	0.50	0.40	26.76	113.40
29	4.92	24.60	0.50	0.60	24.49	112.50
30	5.09	23.70	0.40	5.50	25.45	112.40
31	5.25	22.30	0.50	5.90	26.29	112.32
32	5.41	22.20	0.50	6.30	28.29	112.72
33	5.58	20.60	0.50	6.50	30.67	113.05
34	5.74	18.60	0.60	6.60	31.37	112.99
35	5.91	20.70	0.50	6.80	27.30	112.81
36	6.07	28.40	0.40	6.90	17.03	112.05
37	6.23	47.80	0.30	6.80	8.21	110.99
38	6.40	72.80	0.20	1.00	3.99	111.08
39	6.56	99.70	0.30	-1.00	1.99	112.73
40	6.73	132.30	0.40	-0.60	1.30	116.04
41	6.89	160.00	0.60	-0.30	0.96	118.89
42	7.05	182.70	0.80	-0.10	0.97	121.65
43	7.22	206.90	1.10	0.10	0.97	123.75
44	7.38	230.40	1.30	0.30	0.97	125.44
45	7.55	248.70	1.50	0.50	1.03	126.46
46	7.71	246.50	1.60	0.60	1.29	127.11
47	7.87	235.20	1.70	0.70	1.56	127.20
48	8.04	229.10	1.60	0.80	1.83	127.62

:: Field input data :: (continued)

Point ID	Depth (ft)	q _c (tsf)	f _s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
49	8.20	243.30	1.90	0.80	2.28	128.85
50	8.37	253.80	2.60	1.10	2.93	130.33
51	8.53	249.30	2.90	0.70	3.62	131.55
52	8.69	252.30	3.20	-0.40	3.87	132.25
53	8.86	273.90	3.40	-0.70	3.59	132.52
54	9.02	287.90	3.10	-1.00	3.11	132.40
55	9.19	287.80	2.90	-0.80	2.67	131.96
56	9.35	290.60	2.80	-0.70	2.41	131.44
57	9.51	283.70	2.50	-1.10	1.90	129.98
58	9.68	258.40	1.50	-0.90	1.66	128.54
59	9.84	241.00	1.70	-0.90	1.65	127.59
60	10.01	241.10	1.90	-0.80	3.49	128.69
61	10.17	166.20	2.60	-1.20	6.88	129.03
62	10.34	87.20	2.60	-1.10	14.02	128.43
63	10.50	50.60	2.50	-0.50	22.61	126.83
64	10.66	47.30	2.20	0.60	21.24	126.64
65	10.83	96.10	2.30	1.80	14.51	127.43
66	10.99	136.80	2.40	1.90	8.80	128.29
67	11.16	183.00	2.10	1.10	5.18	128.01
68	11.32	219.50	1.50	0.80	3.25	127.78
69	11.48	235.70	1.90	0.80	2.48	127.86
70	11.65	242.50	2.00	0.70	2.57	128.75
71	11.81	253.40	2.10	0.50	2.50	129.20
72	11.98	263.40	2.20	0.50	2.40	129.50
73	12.14	267.40	2.20	0.50	2.35	129.53
74	12.30	261.10	2.10	0.40	2.51	129.48
75	12.47	248.20	2.20	0.30	3.18	129.67
76	12.63	225.10	2.50	0.10	5.07	130.69
77	12.80	185.40	3.40	-0.10	8.61	131.12
78	12.96	109.80	3.40	-0.60	13.93	130.58
79	13.12	72.30	2.90	-0.20	21.74	129.09
80	13.29	51.50	2.90	0.70	27.52	127.99
81	13.45	51.70	2.90	2.30	27.58	127.89
82	13.62	71.30	2.80	2.60	20.62	128.15
83	13.78	109.00	2.40	2.60	14.57	127.57
84	13.94	115.90	1.70	1.40	10.19	126.63
85	14.11	133.20	1.60	0.90	8.16	126.23
86	14.27	151.00	1.90	0.90	6.43	126.76
87	14.44	185.70	1.80	0.80	4.49	126.38
88	14.60	204.00	1.10	0.60	3.34	126.33
89	14.76	212.70	1.70	0.60	2.99	126.44
90	14.93	212.70	1.80	0.50	3.52	127.34
91	15.09	205.60	1.70	0.10	3.83	127.74
92	15.26	210.40	2.00	0.10	4.04	128.00
93	15.42	211.00	2.00	0.00	4.25	128.39
94	15.58	209.70	2.00	0.00	4.52	128.47
95	15.75	199.90	2.10	-0.10	5.24	128.98
96	15.91	193.50	2.50	-0.20	6.16	129.99

:: Field input data :: (continued)

Point ID	Depth (ft)	q _c (tsf)	f _s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
97	16.08	204.50	3.00	-0.10	6.53	130.78
98	16.24	215.00	2.90	0.00	6.13	130.77
99	16.40	213.00	2.40	-0.10	5.59	130.25
100	16.57	211.20	2.40	-0.10	4.94	129.58
101	16.73	223.90	2.20	-0.30	4.26	129.38
102	16.90	244.70	2.10	-0.10	3.49	129.72
103	17.06	278.20	2.50	0.20	3.00	130.59
104	17.23	306.90	2.80	0.40	2.72	131.67
105	17.39	331.00	3.00	0.60	2.39	132.19
106	17.55	344.90	2.90	0.70	2.15	132.27
107	17.72	338.60	2.80	0.70	2.02	132.11
108	17.88	336.40	2.80	0.60	1.67	131.26
109	18.05	331.50	2.00	0.60	1.46	130.50
110	18.21	317.70	2.10	0.50	1.47	129.58
111	18.37	281.20	2.10	0.40	2.69	129.73
112	18.54	221.90	2.40	-0.40	5.30	129.55
113	18.70	137.10	2.50	-0.70	9.74	128.15
114	18.87	71.10	1.70	-0.90	17.21	125.62
115	19.03	41.50	1.40	-0.90	26.56	122.51
116	19.19	31.30	1.30	-0.20	25.23	121.84
117	19.36	72.70	1.30	1.90	13.83	121.85
118	19.52	133.80	0.80	2.70	6.55	122.35
119	19.69	178.20	1.00	2.30	3.59	123.33
120	19.85	211.40	1.40	2.40	3.00	125.17
121	20.01	225.10	1.50	2.40	3.32	126.85
122	20.18	220.40	1.90	1.80	3.60	127.47
123	20.34	218.60	1.80	1.70	3.53	127.32
124	20.51	224.80	1.40	1.80	4.53	128.46
125	20.67	206.50	2.80	1.40	6.83	129.51
126	20.83	147.70	3.00	1.20	11.01	129.66
127	21.00	93.20	2.20	1.20	12.95	127.02
128	21.16	102.00	0.90	2.80	8.88	124.31
129	21.33	176.00	1.00	2.30	4.20	123.22
130	21.49	221.00	1.30	1.20	2.85	125.26
131	21.65	239.50	1.60	1.20	2.63	126.73
132	21.82	247.90	1.70	1.40	2.67	127.43
133	21.98	248.90	1.70	1.30	2.73	127.59
134	22.15	242.50	1.70	1.20	3.17	127.95
135	22.31	232.50	2.00	1.10	3.86	128.38
136	22.47	222.00	2.10	0.90	3.93	127.76
137	22.64	213.80	1.30	0.80	4.30	127.18
138	22.80	189.70	1.70	0.60	5.47	126.39
139	22.97	139.30	1.80	0.30	9.02	126.20
140	23.13	89.10	1.60	0.10	14.01	124.34
141	23.30	55.70	1.10	0.20	20.60	122.51
142	23.46	46.20	1.30	1.70	21.47	121.52
143	23.62	73.10	1.20	2.20	21.60	121.97
144	23.79	59.50	1.30	2.40	17.48	122.23

:: Field input data :: (continued)

Point ID	Depth (ft)	q _c (tsf)	f _s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
145	23.95	83.10	1.20	2.50	14.03	122.23
146	24.12	111.70	1.00	1.70	9.54	121.91
147	24.28	126.80	0.90	1.30	6.53	121.01
148	24.44	138.50	0.70	1.20	4.98	120.34
149	24.61	147.50	0.70	1.20	4.23	120.16
150	24.77	151.80	0.80	1.10	4.45	121.17
151	24.94	153.00	1.00	0.90	4.74	122.35
152	25.10	164.30	1.10	0.80	4.62	123.96
153	25.26	200.10	1.40	1.10	4.06	125.65
154	25.43	232.90	1.70	1.40	3.40	127.30
155	25.59	265.50	1.90	1.70	2.83	128.43
156	25.76	290.40	2.00	1.90	2.38	129.01
157	25.92	300.00	2.00	1.90	2.30	129.32
158	26.08	290.40	2.10	1.90	3.07	130.03
159	26.25	260.40	2.70	1.70	4.66	130.81
160	26.41	224.40	3.00	1.40	6.64	131.12
161	26.58	194.60	2.80	1.20	8.26	131.00
162	26.74	186.00	2.90	1.60	8.65	131.42
163	26.90	226.00	3.50	2.30	7.33	132.13
164	27.07	280.50	3.30	2.30	5.64	132.66
165	27.23	303.80	3.10	2.20	5.73	133.40
166	27.40	261.00	4.40	2.10	7.62	133.18
167	27.56	164.40	3.50	1.70	12.16	132.24
168	27.72	100.40	2.90	1.40	13.83	130.33
169	27.89	164.00	2.50	3.00	10.40	129.39
170	28.05	222.10	2.10	1.60	6.21	129.07
171	28.22	240.50	2.00	1.50	3.94	128.78
172	28.38	277.00	1.90	1.60	2.86	128.63
173	28.54	294.30	1.80	1.70	2.67	128.98
174	28.71	274.20	2.20	1.40	4.43	129.86
175	28.87	191.30	2.90	1.00	8.30	129.42
176	29.04	92.60	2.10	0.30	15.60	127.16
177	29.20	46.10	1.30	0.10	26.08	122.15
178	29.36	26.10	0.60	1.20	34.30	116.42
179	29.53	22.50	0.30	1.90	41.06	114.26
180	29.69	22.60	0.90	2.80	45.58	117.34
181	29.86	29.50	1.50	2.90	26.88	123.27
182	30.02	119.70	2.20	4.00	20.08	126.23
183	30.19	111.10	2.30	5.10	16.92	127.42
184	30.35	87.80	2.10	4.80	19.09	125.61
185	30.51	63.30	1.10	5.20	21.81	122.62
186	30.68	48.40	0.80	5.90	24.49	120.20
187	30.84	47.40	1.20	6.80	32.01	121.02
188	31.01	34.90	1.70	7.50	40.20	122.23
189	31.17	29.50	1.70	11.00	45.87	122.03
190	31.33	32.20	1.30	10.20	48.33	120.31
191	31.50	21.70	0.90	8.90	48.25	117.84
192	31.66	19.70	0.70	10.20	50.55	115.78

:: Field input data :: (continued)

Point ID	Depth (ft)	q _c (tsf)	f _s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
193	31.83	21.80	0.70	11.30	48.60	115.14
194	31.99	22.50	0.70	12.60	47.98	115.19
195	32.15	20.80	0.70	13.60	42.72	114.70
196	32.32	28.60	0.50	14.80	39.29	115.77
197	32.48	33.30	0.90	14.10	40.81	118.07
198	32.65	27.60	1.40	16.30	33.46	121.40
199	32.81	69.10	1.60	17.50	22.75	124.47
200	32.97	120.90	2.00	19.40	13.70	127.23
201	33.14	183.30	2.50	21.70	10.07	129.55
202	33.30	215.40	3.00	17.10	8.71	131.35
203	33.47	231.00	3.50	14.80	8.44	132.23
204	33.63	230.50	3.40	14.20	7.31	131.33
205	33.79	228.00	1.80	12.80	6.54	130.21
206	33.96	221.50	2.30	11.70	5.32	128.12
207	34.12	208.90	1.60	9.80	5.66	127.27
208	34.29	181.70	1.30	10.40	7.38	126.42
209	34.45	126.40	2.00	8.80	12.89	126.51
210	34.61	70.00	2.20	8.90	22.63	127.39
211	34.78	67.10	2.80	14.50	17.95	129.77
212	34.94	227.10	3.70	19.00	11.64	132.32
213	35.11	277.90	4.10	12.90	7.97	134.63
214	35.27	316.10	5.10	12.60	7.40	136.06
215	35.43	342.40	5.80	12.10	7.03	137.17
216	35.60	376.10	6.00	12.20	6.49	137.28
217	35.76	402.70	6.10	13.10	5.82	137.28
218	35.93	425.70	6.20	13.80	5.14	137.28
219	36.09	442.60	5.70	13.10	4.66	137.28
220	36.26	435.80	5.50	12.40	4.41	137.28
221	36.42	422.80	5.40	12.00	4.55	137.28
222	36.58	417.50	5.50	11.20	4.69	137.28
223	36.75	410.50	5.30	11.30	4.71	137.05
224	36.91	399.00	4.90	11.20	4.59	136.62
225	37.08	396.40	4.70	10.80	4.30	136.15
226	37.24	402.50	4.40	10.70	4.17	136.12
227	37.40	410.60	4.80	11.10	4.09	136.27
228	37.57	417.60	4.90	11.10	4.20	136.61
229	37.73	419.20	5.00	11.40	4.23	136.90
230	37.90	433.70	5.30	11.30	4.29	137.28
231	38.06	444.50	5.60	11.60	4.29	137.28
232	38.22	449.80	5.60	12.00	4.30	137.28
233	38.39	447.40	5.60	11.70	4.23	137.28
234	38.55	454.90	5.60	11.30	4.17	137.28
235	38.72	469.20	5.80	11.80	4.09	137.28
236	38.88	478.60	6.00	12.00	4.01	137.28
237	39.04	482.90	5.90	11.90	3.91	137.28
238	39.21	470.50	5.50	12.20	3.81	137.28
239	39.37	444.30	5.00	11.80	3.79	136.97
240	39.54	421.90	4.60	10.90	3.43	136.22

:: Field input data :: (continued)

Point ID	Depth (ft)	q _c (tsf)	f _s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
241	39.70	446.20	4.10	10.60	3.18	136.03
242	39.86	459.10	4.60	11.50	3.00	136.08
243	40.03	449.10	4.60	11.30	3.09	135.86
244	40.19	418.20	3.80	10.30	2.94	134.84
245	40.36	392.20	3.10	8.80	2.51	133.03
246	40.52	361.30	2.30	8.20	2.47	131.40
247	40.68	312.80	2.20	6.80	3.33	130.34
248	40.85	250.90	2.40	5.50	6.11	130.43
249	41.01	182.10	2.90	3.30	10.90	130.15
250	41.18	114.00	2.70	3.00	18.01	128.66
251	41.34	64.90	1.90	2.80	26.29	125.49
252	41.50	45.20	1.10	3.70	32.70	121.32
253	41.67	37.90	0.70	7.10	36.11	117.80
254	41.83	29.90	0.70	17.60	39.27	115.73
255	42.00	26.50	0.60	22.90	44.01	115.01
256	42.16	24.90	0.60	27.10	46.13	114.44
257	42.32	24.00	0.60	31.60	46.77	113.93
258	42.49	23.70	0.50	35.50	46.56	113.45
259	42.65	23.60	0.50	38.60	45.81	113.50
260	42.82	25.30	0.60	43.70	44.89	114.06
261	42.98	27.10	0.60	47.70	44.40	115.01
262	43.15	27.90	0.70	51.30	44.04	115.46
263	43.31	27.70	0.70	54.60	44.88	115.81
264	43.47	26.90	0.70	58.40	45.03	115.41
265	43.64	26.00	0.60	63.10	44.65	114.57
266	43.80	25.20	0.50	66.00	44.24	113.63
267	43.97	24.20	0.50	71.70	44.86	113.59
268	44.13	24.50	0.60	93.60	45.37	114.07
269	44.29	25.60	0.60	99.90	44.69	114.58
270	44.46	27.00	0.60	98.90	42.76	114.23
271	44.62	26.80	0.50	101.70	40.69	113.34
272	44.79	26.30	0.40	110.50	40.73	112.78
273	44.95	24.80	0.50	110.80	46.14	114.51
274	45.11	22.90	0.90	128.20	54.62	118.51
275	45.28	26.20	1.70	172.00	42.86	123.38
276	45.44	76.20	2.50	152.30	24.66	127.82
277	45.61	169.60	3.10	50.00	13.53	130.66
278	45.77	257.90	3.20	13.00	8.90	132.01
279	45.93	273.00	3.20	0.10	7.37	133.14
280	46.10	295.60	4.10	-1.00	7.11	134.63
281	46.26	354.70	5.10	-1.20	6.33	136.08
282	46.43	417.40	5.20	-1.20	4.97	136.43
283	46.59	434.80	4.20	-0.80	3.84	135.33
284	46.75	380.50	3.00	-0.50	3.54	134.13
285	46.92	357.50	3.50	-1.00	3.27	133.79
286	47.08	439.00	3.70	0.50	3.21	134.77
287	47.25	462.20	4.20	2.10	3.01	135.55
288	47.41	446.20	4.50	2.00	3.21	136.37

:: Field input data :: (continued)						
Point ID	Depth (ft)	q _c (tsf)	f _s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
289	47.57	488.10	5.00	2.20	3.53	137.02
290	47.74	482.40	5.40	2.50	3.76	137.28
291	47.90	473.60	5.60	2.60	4.29	137.28
292	48.07	444.80	5.60	3.50	4.72	137.28
293	48.23	417.70	5.20	2.90	5.04	137.28
294	48.39	423.40	5.30	2.30	5.09	137.23
295	48.56	430.60	5.40	2.50	4.91	136.65
296	48.72	388.10	4.10	2.60	5.04	135.56
297	48.89	329.90	3.60	1.80	6.52	134.64
298	49.05	257.50	4.50	1.40	9.52	134.66
299	49.22	225.40	4.90	1.20	14.33	134.73
300	49.38	158.00	4.80	1.10	18.27	134.01
301	49.54	136.00	4.10	2.10	17.14	132.19
302	49.71	193.40	2.10	3.10	12.65	130.56
303	49.87	211.40	2.30	1.70	8.69	129.14

Abbreviations

Depth:	Depth from free surface, at which CPT was performed (ft)
q _c :	Measured cone resistance (tsf)
f _s :	Sleeve friction resistance (tsf)
u:	Pore pressure (tsf)
Fines content:	Percentage of fines in soil (%)
Unit weight:	Bulk soil unit weight (pcf)

:: Cyclic Stress Ratio fully adjusted (CSR*) calculation data ::												
Point ID	Depth (ft)	σ_v (tsf)	u_0 (tsf)	σ'_v (tsf)	r_d	CSR	MSF	CSR_{eq}	K_G	User FS	CSR*	Belongs to transition
1	0.33	0.02	0.00	0.02	1.00	0.826	0.82	1.006	1.00	1.00	2.000	No
2	0.49	0.03	0.00	0.03	1.00	0.826	0.82	1.006	1.00	1.00	2.000	No
3	0.66	0.04	0.00	0.04	1.00	0.826	0.82	1.006	1.00	1.00	2.000	No
4	0.82	0.05	0.00	0.05	1.00	0.825	0.82	1.006	1.00	1.00	2.000	No
5	0.98	0.05	0.00	0.05	1.00	0.825	0.82	1.005	1.00	1.00	2.000	No
6	1.15	0.06	0.00	0.06	1.00	0.825	0.82	1.005	1.00	1.00	2.000	No
7	1.31	0.07	0.00	0.07	1.00	0.825	0.82	1.005	1.00	1.00	2.000	No
8	1.48	0.08	0.00	0.08	1.00	0.824	0.82	1.004	1.00	1.00	2.000	No
9	1.64	0.09	0.00	0.09	1.00	0.824	0.82	1.004	1.00	1.00	2.000	No
10	1.80	0.10	0.00	0.10	1.00	0.824	0.82	1.003	1.00	1.00	2.000	No
11	1.97	0.11	0.00	0.11	1.00	0.823	0.82	1.003	1.00	1.00	2.000	No
12	2.13	0.11	0.00	0.11	1.00	0.823	0.82	1.003	1.00	1.00	2.000	No
13	2.30	0.12	0.00	0.12	1.00	0.823	0.82	1.002	1.00	1.00	2.000	No
14	2.46	0.13	0.00	0.13	1.00	0.822	0.82	1.002	1.00	1.00	2.000	No
15	2.62	0.13	0.00	0.13	1.00	0.822	0.82	1.001	1.00	1.00	2.000	No
16	2.79	0.14	0.00	0.14	1.00	0.822	0.82	1.001	1.00	1.00	2.000	No
17	2.95	0.15	0.00	0.15	1.00	0.821	0.82	1.001	1.00	1.00	2.000	No
18	3.12	0.16	0.00	0.16	0.99	0.821	0.82	1.000	1.00	1.00	2.000	No
19	3.28	0.16	0.00	0.16	0.99	0.821	0.82	1.000	1.00	1.00	2.000	No
20	3.45	0.17	0.00	0.17	0.99	0.820	0.82	0.999	1.00	1.00	2.000	No
21	3.61	0.18	0.00	0.18	0.99	0.820	0.82	0.999	1.00	1.00	2.000	No
22	3.77	0.19	0.00	0.19	0.99	0.820	0.82	0.999	1.00	1.00	2.000	No
23	3.94	0.20	0.00	0.20	0.99	0.819	0.82	0.998	1.00	1.00	2.000	No
24	4.10	0.20	0.00	0.20	0.99	0.819	0.82	0.998	1.00	1.00	2.000	No
25	4.27	0.21	0.00	0.21	0.99	0.819	0.82	0.998	1.00	1.00	2.000	No
26	4.43	0.22	0.00	0.22	0.99	0.819	0.82	0.997	1.00	1.00	2.000	No
27	4.59	0.23	0.00	0.23	0.99	0.818	0.82	0.997	1.00	1.00	2.000	No
28	4.76	0.24	0.00	0.24	0.99	0.818	0.82	0.996	1.00	1.00	2.000	No
29	4.92	0.25	0.00	0.25	0.99	0.818	0.82	0.996	1.00	1.00	2.000	No
30	5.09	0.26	0.00	0.26	0.99	0.826	0.82	1.006	1.00	1.00	1.006	No
31	5.25	0.27	0.01	0.26	0.99	0.841	0.82	1.025	1.00	1.00	1.025	No
32	5.41	0.28	0.01	0.26	0.99	0.856	0.82	1.043	1.00	1.00	1.043	No
33	5.58	0.29	0.02	0.27	0.99	0.871	0.82	1.061	1.00	1.00	1.061	No
34	5.74	0.30	0.02	0.27	0.99	0.885	0.82	1.078	1.00	1.00	2.000	Yes
35	5.91	0.31	0.03	0.28	0.99	0.899	0.82	1.095	1.00	1.00	2.000	Yes
36	6.07	0.31	0.03	0.28	0.99	0.912	0.82	1.111	1.00	1.00	2.000	Yes
37	6.23	0.32	0.04	0.29	0.99	0.925	0.82	1.127	1.00	1.00	2.000	Yes
38	6.40	0.33	0.04	0.29	0.99	0.938	0.82	1.142	1.00	1.00	1.142	No
39	6.56	0.34	0.05	0.29	0.99	0.950	0.82	1.157	1.00	1.00	1.157	No
40	6.73	0.35	0.05	0.30	0.99	0.962	0.82	1.172	1.00	1.00	1.172	No
41	6.89	0.36	0.06	0.30	0.99	0.973	0.82	1.185	1.00	1.00	1.185	No
42	7.05	0.37	0.06	0.31	0.99	0.983	0.82	1.197	1.00	1.00	1.197	No
43	7.22	0.38	0.07	0.31	0.99	0.994	0.82	1.210	1.00	1.00	1.210	No
44	7.38	0.39	0.07	0.32	0.98	1.003	0.82	1.222	1.00	1.00	1.222	No
45	7.55	0.40	0.08	0.32	0.98	1.013	0.82	1.234	1.00	1.00	1.234	No
46	7.71	0.41	0.08	0.33	0.98	1.022	0.82	1.245	1.00	1.00	1.245	No
47	7.87	0.42	0.09	0.33	0.98	1.030	0.82	1.255	1.00	1.00	1.255	No
48	8.04	0.43	0.09	0.34	0.98	1.039	0.82	1.266	1.00	1.00	1.266	No

:: Cyclic Stress Ratio fully adjusted (CSR*) calculation data :: (continued)

Point ID	Depth (ft)	σ_v (tsf)	u_0 (tsf)	σ'_v (tsf)	r_d	CSR	MSF	CSR_{eq}	K_G	User FS	CSR^*	Belongs to transition
49	8.20	0.44	0.10	0.34	0.98	1.047	0.82	1.275	1.00	1.00	1.275	No
50	8.37	0.46	0.11	0.35	0.98	1.055	0.82	1.285	1.00	1.00	1.285	No
51	8.53	0.47	0.11	0.36	0.98	1.062	0.82	1.294	1.00	1.00	1.294	No
52	8.69	0.48	0.12	0.36	0.98	1.069	0.82	1.302	1.00	1.00	1.302	No
53	8.86	0.49	0.12	0.37	0.98	1.076	0.82	1.311	1.00	1.00	1.311	No
54	9.02	0.50	0.13	0.37	0.98	1.083	0.82	1.319	1.00	1.00	1.319	No
55	9.19	0.51	0.13	0.38	0.98	1.089	0.82	1.327	1.00	1.00	1.327	No
56	9.35	0.52	0.14	0.38	0.98	1.096	0.82	1.335	1.00	1.00	1.335	No
57	9.51	0.53	0.14	0.39	0.98	1.102	0.82	1.342	1.00	1.00	1.342	No
58	9.68	0.54	0.15	0.40	0.98	1.108	0.82	1.350	1.00	1.00	1.350	No
59	9.84	0.55	0.15	0.40	0.98	1.114	0.82	1.357	1.00	1.00	1.357	No
60	10.01	0.56	0.16	0.41	0.98	1.120	0.82	1.364	1.00	1.00	1.364	No
61	10.17	0.57	0.16	0.41	0.98	1.125	0.82	1.370	1.00	1.00	1.370	No
62	10.34	0.58	0.17	0.42	0.98	1.131	0.82	1.377	1.00	1.00	1.377	No
63	10.50	0.59	0.17	0.42	0.98	1.136	0.82	1.384	1.00	1.00	1.384	No
64	10.66	0.60	0.18	0.43	0.98	1.141	0.82	1.390	1.00	1.00	1.390	No
65	10.83	0.61	0.18	0.43	0.98	1.146	0.82	1.396	1.00	1.00	1.396	No
66	10.99	0.62	0.19	0.44	0.98	1.151	0.82	1.402	1.00	1.00	1.402	No
67	11.16	0.64	0.19	0.44	0.98	1.156	0.82	1.408	1.00	1.00	1.408	No
68	11.32	0.65	0.20	0.45	0.98	1.160	0.82	1.413	1.00	1.00	1.413	No
69	11.48	0.66	0.20	0.45	0.98	1.165	0.82	1.419	1.00	1.00	1.419	No
70	11.65	0.67	0.21	0.46	0.98	1.169	0.82	1.424	1.00	1.00	1.424	No
71	11.81	0.68	0.21	0.46	0.98	1.173	0.82	1.429	1.00	1.00	1.429	No
72	11.98	0.69	0.22	0.47	0.97	1.177	0.82	1.434	1.00	1.00	1.434	No
73	12.14	0.70	0.22	0.48	0.97	1.181	0.82	1.439	1.00	1.00	1.439	No
74	12.30	0.71	0.23	0.48	0.97	1.185	0.82	1.443	1.00	1.00	1.443	No
75	12.47	0.72	0.23	0.49	0.97	1.189	0.82	1.448	1.00	1.00	1.448	No
76	12.63	0.73	0.24	0.49	0.97	1.192	0.82	1.452	1.00	1.00	1.452	No
77	12.80	0.74	0.24	0.50	0.97	1.196	0.82	1.457	1.00	1.00	1.457	No
78	12.96	0.75	0.25	0.50	0.97	1.199	0.82	1.461	1.00	1.00	1.461	No
79	13.12	0.76	0.25	0.51	0.97	1.202	0.82	1.465	1.00	1.00	1.465	No
80	13.29	0.77	0.26	0.51	0.97	1.206	0.82	1.469	1.00	1.00	1.469	No
81	13.45	0.78	0.26	0.52	0.97	1.209	0.82	1.473	1.00	1.00	1.473	No
82	13.62	0.79	0.27	0.53	0.97	1.212	0.82	1.477	1.00	1.00	1.477	No
83	13.78	0.80	0.27	0.53	0.97	1.215	0.82	1.481	1.00	1.00	1.481	No
84	13.94	0.81	0.28	0.54	0.97	1.218	0.82	1.484	1.00	1.00	1.484	No
85	14.11	0.83	0.28	0.54	0.97	1.222	0.82	1.488	1.00	1.00	1.488	No
86	14.27	0.84	0.29	0.55	0.97	1.225	0.82	1.492	1.00	1.00	1.492	No
87	14.44	0.85	0.29	0.55	0.97	1.228	0.82	1.496	1.00	1.00	1.496	No
88	14.60	0.86	0.30	0.56	0.97	1.231	0.82	1.499	1.00	1.00	1.499	No
89	14.76	0.87	0.30	0.56	0.97	1.233	0.82	1.502	1.00	1.00	1.502	No
90	14.93	0.88	0.31	0.57	0.97	1.236	0.82	1.506	1.00	1.00	1.506	No
91	15.09	0.89	0.31	0.57	0.97	1.239	0.82	1.509	1.00	1.00	1.509	No
92	15.26	0.90	0.32	0.58	0.97	1.241	0.82	1.512	1.00	1.00	1.512	No
93	15.42	0.91	0.33	0.58	0.97	1.244	0.82	1.515	1.00	1.00	1.515	No
94	15.58	0.92	0.33	0.59	0.97	1.246	0.82	1.518	1.00	1.00	1.518	No
95	15.75	0.93	0.34	0.59	0.97	1.248	0.82	1.521	1.00	1.00	1.521	No
96	15.91	0.94	0.34	0.60	0.97	1.250	0.82	1.523	1.00	1.00	1.523	No

:: Cyclic Stress Ratio fully adjusted (CSR*) calculation data :: (continued)												
Point ID	Depth (ft)	σ_v (tsf)	u_0 (tsf)	σ'_v (tsf)	r_d	CSR	MSF	CSR_{eq}	K_G	User FS	CSR*	Belongs to transition
97	16.08	0.95	0.35	0.61	0.97	1.253	0.82	1.526	1.00	1.00	1.526	No
98	16.24	0.96	0.35	0.61	0.97	1.255	0.82	1.528	1.00	1.00	1.528	No
99	16.40	0.97	0.36	0.62	0.97	1.257	0.82	1.531	1.00	1.00	1.531	No
100	16.57	0.98	0.36	0.62	0.97	1.259	0.82	1.533	1.00	1.00	1.533	No
101	16.73	0.99	0.37	0.63	0.96	1.261	0.82	1.536	1.00	1.00	1.536	No
102	16.90	1.00	0.37	0.63	0.96	1.263	0.82	1.538	1.00	1.00	1.538	No
103	17.06	1.02	0.38	0.64	0.96	1.264	0.82	1.540	1.00	1.00	1.540	No
104	17.23	1.03	0.38	0.65	0.96	1.266	0.82	1.542	1.00	1.00	1.542	No
105	17.39	1.04	0.39	0.65	0.96	1.268	0.82	1.544	1.00	1.00	1.544	No
106	17.55	1.05	0.39	0.66	0.96	1.269	0.82	1.546	1.00	1.00	1.546	No
107	17.72	1.06	0.40	0.66	0.96	1.271	0.82	1.548	1.00	1.00	1.548	No
108	17.88	1.07	0.40	0.67	0.96	1.272	0.82	1.550	1.00	1.00	1.550	No
109	18.05	1.08	0.41	0.67	0.96	1.274	0.82	1.552	1.00	1.00	1.552	No
110	18.21	1.09	0.41	0.68	0.96	1.275	0.82	1.554	1.00	1.00	1.554	No
111	18.37	1.10	0.42	0.68	0.96	1.277	0.82	1.556	1.00	1.00	1.556	No
112	18.54	1.11	0.42	0.69	0.96	1.278	0.82	1.557	1.00	1.00	1.557	No
113	18.70	1.12	0.43	0.70	0.96	1.280	0.82	1.559	1.00	1.00	1.559	No
114	18.87	1.13	0.43	0.70	0.96	1.282	0.82	1.561	1.00	1.00	1.561	No
115	19.03	1.14	0.44	0.71	0.96	1.283	0.82	1.563	1.00	1.00	1.563	No
116	19.19	1.15	0.44	0.71	0.96	1.285	0.82	1.566	1.00	1.00	1.566	No
117	19.36	1.16	0.45	0.72	0.96	1.287	0.82	1.568	1.00	1.00	1.568	No
118	19.52	1.17	0.45	0.72	0.96	1.289	0.82	1.570	1.00	1.00	1.570	No
119	19.69	1.18	0.46	0.73	0.96	1.290	0.82	1.572	1.00	1.00	1.572	No
120	19.85	1.19	0.46	0.73	0.96	1.292	0.82	1.574	1.00	1.00	1.574	No
121	20.01	1.20	0.47	0.74	0.96	1.293	0.82	1.575	1.00	1.00	1.575	No
122	20.18	1.21	0.47	0.74	0.96	1.294	0.82	1.577	1.00	1.00	1.577	No
123	20.34	1.22	0.48	0.75	0.96	1.295	0.82	1.578	1.00	1.00	1.578	No
124	20.51	1.24	0.48	0.75	0.96	1.297	0.82	1.580	1.00	1.00	1.580	No
125	20.67	1.25	0.49	0.76	0.96	1.298	0.82	1.581	1.00	1.00	1.581	No
126	20.83	1.26	0.49	0.76	0.95	1.299	0.82	1.582	1.00	1.00	1.582	No
127	21.00	1.27	0.50	0.77	0.95	1.300	0.82	1.583	1.00	1.00	1.583	No
128	21.16	1.28	0.50	0.77	0.95	1.301	0.82	1.585	1.00	1.00	1.585	No
129	21.33	1.29	0.51	0.78	0.95	1.302	0.82	1.587	1.00	1.00	1.587	No
130	21.49	1.30	0.51	0.78	0.95	1.303	0.82	1.588	1.00	1.00	1.588	No
131	21.65	1.31	0.52	0.79	0.95	1.304	0.82	1.589	1.00	1.00	1.589	No
132	21.82	1.32	0.52	0.79	0.95	1.305	0.82	1.590	1.00	1.00	1.590	No
133	21.98	1.33	0.53	0.80	0.95	1.306	0.82	1.591	1.00	1.00	1.591	No
134	22.15	1.34	0.54	0.80	0.95	1.307	0.82	1.592	1.00	1.00	1.592	No
135	22.31	1.35	0.54	0.81	0.95	1.308	0.82	1.593	1.00	1.00	1.593	No
136	22.47	1.36	0.55	0.81	0.95	1.309	0.82	1.594	1.00	1.00	1.594	No
137	22.64	1.37	0.55	0.82	0.95	1.310	0.82	1.595	1.00	1.00	1.595	No
138	22.80	1.38	0.56	0.83	0.95	1.310	0.82	1.596	1.00	1.00	1.596	No
139	22.97	1.39	0.56	0.83	0.95	1.311	0.82	1.597	1.00	1.00	1.597	No
140	23.13	1.40	0.57	0.84	0.95	1.312	0.82	1.598	1.00	1.00	1.598	No
141	23.30	1.41	0.57	0.84	0.95	1.313	0.82	1.600	1.00	1.00	1.600	No
142	23.46	1.42	0.58	0.85	0.95	1.314	0.82	1.601	1.00	1.00	1.601	No
143	23.62	1.43	0.58	0.85	0.95	1.315	0.82	1.602	1.00	1.00	1.602	No
144	23.79	1.44	0.59	0.86	0.95	1.316	0.82	1.603	1.00	1.00	1.603	No

:: Cyclic Stress Ratio fully adjusted (CSR*) calculation data :: (continued)

Point ID	Depth (ft)	σ_v (tsf)	u_0 (tsf)	σ'_v (tsf)	r_d	CSR	MSF	CSR_{eq}	K_G	User FS	CSR*	Belongs to transition
145	23.95	1.45	0.59	0.86	0.95	1.317	0.82	1.604	1.00	1.00	1.604	No
146	24.12	1.46	0.60	0.87	0.94	1.318	0.82	1.605	1.00	1.00	1.605	No
147	24.28	1.47	0.60	0.87	0.94	1.318	0.82	1.606	1.00	1.00	1.606	No
148	24.44	1.48	0.61	0.87	0.94	1.319	0.82	1.607	1.00	1.00	1.607	No
149	24.61	1.49	0.61	0.88	0.94	1.320	0.82	1.608	1.00	1.00	1.608	No
150	24.77	1.50	0.62	0.88	0.94	1.321	0.82	1.609	1.00	1.00	1.609	No
151	24.94	1.51	0.62	0.89	0.94	1.322	0.82	1.610	1.00	1.00	1.610	No
152	25.10	1.52	0.63	0.89	0.94	1.322	0.82	1.611	1.00	1.00	1.611	No
153	25.26	1.53	0.63	0.90	0.94	1.323	0.82	1.611	1.00	1.00	1.611	No
154	25.43	1.54	0.64	0.91	0.94	1.323	0.82	1.612	1.00	1.00	1.612	No
155	25.59	1.55	0.64	0.91	0.94	1.323	0.82	1.612	1.00	1.00	1.612	No
156	25.76	1.56	0.65	0.92	0.94	1.323	0.82	1.612	1.00	1.00	1.612	No
157	25.92	1.57	0.65	0.92	0.94	1.324	0.82	1.612	1.00	1.00	1.612	No
158	26.08	1.58	0.66	0.93	0.94	1.324	0.82	1.612	1.00	1.00	1.612	No
159	26.25	1.60	0.66	0.93	0.94	1.324	0.82	1.613	1.00	1.00	1.613	No
160	26.41	1.61	0.67	0.94	0.94	1.324	0.82	1.613	1.00	1.00	1.613	No
161	26.58	1.62	0.67	0.94	0.94	1.324	0.82	1.613	1.00	1.00	1.613	No
162	26.74	1.63	0.68	0.95	0.94	1.324	0.82	1.613	1.00	1.00	1.613	No
163	26.90	1.64	0.68	0.96	0.93	1.324	0.82	1.612	1.00	1.00	1.612	No
164	27.07	1.65	0.69	0.96	0.93	1.323	0.82	1.612	1.00	1.00	1.612	No
165	27.23	1.66	0.69	0.97	0.93	1.323	0.82	1.612	1.00	1.00	1.612	No
166	27.40	1.67	0.70	0.97	0.93	1.323	0.82	1.612	1.00	1.00	1.612	No
167	27.56	1.68	0.70	0.98	0.93	1.323	0.82	1.611	1.00	1.00	1.611	No
168	27.72	1.69	0.71	0.98	0.93	1.323	0.82	1.611	1.00	1.00	1.611	No
169	27.89	1.70	0.71	0.99	0.93	1.323	0.82	1.611	1.00	1.00	1.611	No
170	28.05	1.71	0.72	0.99	0.93	1.322	0.82	1.611	1.00	1.00	1.611	No
171	28.22	1.72	0.72	1.00	0.93	1.322	0.82	1.611	1.00	1.00	1.611	No
172	28.38	1.74	0.73	1.01	0.93	1.322	0.82	1.611	1.00	1.00	1.611	No
173	28.54	1.75	0.73	1.01	0.93	1.322	0.82	1.610	1.00	1.00	1.610	No
174	28.71	1.76	0.74	1.02	0.93	1.322	0.82	1.610	1.00	1.00	1.610	No
175	28.87	1.77	0.74	1.02	0.93	1.322	0.82	1.610	1.00	1.00	2.000	Yes
176	29.04	1.78	0.75	1.03	0.93	1.321	0.82	1.610	1.00	1.00	2.000	Yes
177	29.20	1.79	0.76	1.03	0.92	1.321	0.82	1.610	1.00	1.00	2.000	Yes
178	29.36	1.80	0.76	1.04	0.92	1.322	0.82	1.610	1.00	1.00	2.000	Yes
179	29.53	1.81	0.77	1.04	0.92	1.322	0.82	1.610	1.00	1.00	2.000	Yes
180	29.69	1.82	0.77	1.05	0.92	1.322	0.82	1.611	1.00	1.00	2.000	Yes
181	29.86	1.83	0.78	1.05	0.92	1.322	0.82	1.610	1.00	1.00	2.000	Yes
182	30.02	1.84	0.78	1.06	0.92	1.322	0.82	1.610	1.00	1.00	2.000	Yes
183	30.19	1.85	0.79	1.06	0.92	1.321	0.82	1.610	1.00	1.00	2.000	Yes
184	30.35	1.86	0.79	1.07	0.92	1.321	0.82	1.609	1.00	1.00	2.000	Yes
185	30.51	1.87	0.80	1.07	0.92	1.321	0.82	1.609	1.00	1.00	2.000	Yes
186	30.68	1.88	0.80	1.08	0.92	1.321	0.82	1.609	1.00	1.00	2.000	Yes
187	30.84	1.89	0.81	1.08	0.92	1.321	0.82	1.609	1.00	1.00	2.000	Yes
188	31.01	1.90	0.81	1.09	0.92	1.320	0.82	1.608	1.00	1.00	2.000	Yes
189	31.17	1.91	0.82	1.09	0.91	1.320	0.82	1.608	1.00	1.00	2.000	Yes
190	31.33	1.92	0.82	1.10	0.91	1.320	0.82	1.608	1.00	1.00	1.608	No
191	31.50	1.93	0.83	1.10	0.91	1.320	0.82	1.608	1.00	1.00	1.608	No
192	31.66	1.94	0.83	1.10	0.91	1.320	0.82	1.607	1.00	1.00	1.607	No

:: Cyclic Stress Ratio fully adjusted (CSR*) calculation data :: (continued)												
Point ID	Depth (ft)	σ_v (tsf)	u_0 (tsf)	σ'_v (tsf)	r_d	CSR	MSF	CSR_{eq}	K_G	User FS	CSR*	Belongs to transition
193	31.83	1.95	0.84	1.11	0.91	1.319	0.82	1.607	1.00	1.00	1.607	No
194	31.99	1.96	0.84	1.11	0.91	1.319	0.82	1.607	1.00	1.00	1.607	No
195	32.15	1.96	0.85	1.12	0.91	1.319	0.82	1.607	1.00	1.00	1.607	No
196	32.32	1.97	0.85	1.12	0.91	1.319	0.82	1.607	1.00	1.00	1.607	No
197	32.48	1.98	0.86	1.13	0.91	1.319	0.82	1.606	1.00	1.00	2.000	Yes
198	32.65	1.99	0.86	1.13	0.91	1.318	0.82	1.606	1.00	1.00	2.000	Yes
199	32.81	2.00	0.87	1.14	0.90	1.318	0.82	1.605	1.00	1.00	2.000	Yes
200	32.97	2.01	0.87	1.14	0.90	1.317	0.82	1.604	1.00	1.00	2.000	Yes
201	33.14	2.02	0.88	1.15	0.90	1.316	0.82	1.603	1.00	1.00	2.000	Yes
202	33.30	2.04	0.88	1.15	0.90	1.315	0.82	1.602	1.00	1.00	2.000	Yes
203	33.47	2.05	0.89	1.16	0.90	1.314	0.82	1.600	1.00	1.00	1.600	No
204	33.63	2.06	0.89	1.16	0.90	1.313	0.82	1.599	1.00	1.00	1.599	No
205	33.79	2.07	0.90	1.17	0.90	1.312	0.82	1.598	1.00	1.00	1.598	No
206	33.96	2.08	0.90	1.17	0.90	1.311	0.82	1.597	1.00	1.00	1.597	No
207	34.12	2.09	0.91	1.18	0.90	1.310	0.82	1.596	1.00	1.00	1.596	No
208	34.29	2.10	0.91	1.19	0.90	1.309	0.82	1.595	1.00	1.00	1.595	No
209	34.45	2.11	0.92	1.19	0.89	1.308	0.82	1.593	1.00	1.00	1.593	No
210	34.61	2.12	0.92	1.20	0.89	1.307	0.82	1.592	1.00	1.00	1.592	No
211	34.78	2.13	0.93	1.20	0.89	1.306	0.82	1.591	1.00	1.00	1.591	No
212	34.94	2.14	0.93	1.21	0.89	1.305	0.82	1.589	1.00	1.00	1.589	No
213	35.11	2.15	0.94	1.21	0.89	1.303	0.82	1.588	1.00	1.00	1.588	No
214	35.27	2.16	0.94	1.22	0.89	1.302	0.82	1.586	1.00	1.00	1.586	No
215	35.43	2.17	0.95	1.23	0.89	1.300	0.82	1.584	1.00	1.00	1.584	No
216	35.60	2.19	0.95	1.23	0.89	1.299	0.82	1.582	1.00	1.00	1.582	No
217	35.76	2.20	0.96	1.24	0.89	1.297	0.82	1.580	1.00	1.00	1.580	No
218	35.93	2.21	0.97	1.24	0.88	1.296	0.82	1.579	1.00	1.00	1.579	No
219	36.09	2.22	0.97	1.25	0.88	1.294	0.82	1.577	1.00	1.00	1.577	No
220	36.26	2.23	0.98	1.26	0.88	1.293	0.82	1.575	1.00	1.00	1.575	No
221	36.42	2.24	0.98	1.26	0.88	1.291	0.82	1.573	1.00	1.00	1.573	No
222	36.58	2.25	0.99	1.27	0.88	1.289	0.82	1.571	1.00	1.00	1.571	No
223	36.75	2.27	0.99	1.27	0.88	1.288	0.82	1.569	1.00	1.00	1.569	No
224	36.91	2.28	1.00	1.28	0.88	1.286	0.82	1.567	1.00	1.00	1.567	No
225	37.08	2.29	1.00	1.29	0.88	1.285	0.82	1.565	1.00	1.00	1.565	No
226	37.24	2.30	1.01	1.29	0.87	1.283	0.82	1.563	1.00	1.00	1.563	No
227	37.40	2.31	1.01	1.30	0.87	1.281	0.82	1.561	1.00	1.00	1.561	No
228	37.57	2.32	1.02	1.30	0.87	1.280	0.82	1.559	1.00	1.00	1.559	No
229	37.73	2.33	1.02	1.31	0.87	1.278	0.82	1.557	1.00	1.00	1.557	No
230	37.90	2.34	1.03	1.32	0.87	1.276	0.82	1.554	1.00	1.00	1.554	No
231	38.06	2.35	1.03	1.32	0.87	1.274	0.82	1.552	1.00	1.00	1.552	No
232	38.22	2.37	1.04	1.33	0.87	1.273	0.82	1.550	1.00	1.00	1.550	No
233	38.39	2.38	1.04	1.34	0.86	1.271	0.82	1.548	1.00	1.00	1.548	No
234	38.55	2.39	1.05	1.34	0.86	1.269	0.82	1.546	1.00	1.00	1.546	No
235	38.72	2.40	1.05	1.35	0.86	1.267	0.82	1.543	1.00	1.00	1.543	No
236	38.88	2.41	1.06	1.35	0.86	1.265	0.82	1.541	1.00	1.00	1.541	No
237	39.04	2.42	1.06	1.36	0.86	1.263	0.82	1.539	1.00	1.00	1.539	No
238	39.21	2.43	1.07	1.37	0.86	1.261	0.82	1.537	1.00	1.00	1.537	No
239	39.37	2.44	1.07	1.37	0.86	1.260	0.82	1.534	1.00	1.00	1.534	No
240	39.54	2.46	1.08	1.38	0.86	1.258	0.82	1.532	1.00	1.00	1.532	No

:: Cyclic Stress Ratio fully adjusted (CSR*) calculation data :: (continued)												
Point ID	Depth (ft)	σ_v (tsf)	u_0 (tsf)	σ'_v (tsf)	r_d	CSR	MSF	CSR_{eq}	K_G	User FS	CSR*	Belongs to transition
241	39.70	2.47	1.08	1.38	0.85	1.256	0.82	1.530	1.00	1.00	1.530	No
242	39.86	2.48	1.09	1.39	0.85	1.254	0.82	1.528	1.00	1.00	1.528	No
243	40.03	2.49	1.09	1.40	0.85	1.252	0.82	1.525	1.00	1.00	1.525	No
244	40.19	2.50	1.10	1.40	0.85	1.250	0.82	1.523	1.00	1.00	1.523	No
245	40.36	2.51	1.10	1.41	0.85	1.248	0.82	1.520	1.00	1.00	1.520	No
246	40.52	2.52	1.11	1.41	0.85	1.246	0.82	1.518	1.00	1.00	1.518	No
247	40.68	2.53	1.11	1.42	0.84	1.245	0.82	1.516	1.00	1.00	1.516	No
248	40.85	2.54	1.12	1.43	0.84	1.243	0.82	1.514	1.00	1.00	1.514	No
249	41.01	2.55	1.12	1.43	0.84	1.241	0.82	1.512	1.00	1.00	2.000	Yes
250	41.18	2.57	1.13	1.44	0.84	1.239	0.82	1.509	1.00	1.00	2.000	Yes
251	41.34	2.58	1.13	1.44	0.84	1.237	0.82	1.507	1.00	1.00	2.000	Yes
252	41.50	2.58	1.14	1.45	0.84	1.236	0.82	1.505	1.00	1.00	2.000	Yes
253	41.67	2.59	1.14	1.45	0.84	1.234	0.82	1.504	1.00	1.00	2.000	Yes
254	41.83	2.60	1.15	1.45	0.83	1.233	0.82	1.502	1.00	1.00	2.000	Yes
255	42.00	2.61	1.15	1.46	0.83	1.231	0.82	1.500	1.00	1.00	2.000	Yes
256	42.16	2.62	1.16	1.46	0.83	1.230	0.82	1.498	1.00	1.00	1.498	No
257	42.32	2.63	1.16	1.47	0.83	1.228	0.82	1.496	1.00	1.00	1.496	No
258	42.49	2.64	1.17	1.47	0.83	1.227	0.82	1.495	1.00	1.00	1.495	No
259	42.65	2.65	1.17	1.48	0.83	1.225	0.82	1.493	1.00	1.00	1.493	No
260	42.82	2.66	1.18	1.48	0.83	1.224	0.82	1.491	1.00	1.00	1.491	No
261	42.98	2.67	1.18	1.48	0.82	1.222	0.82	1.489	1.00	1.00	1.489	No
262	43.15	2.68	1.19	1.49	0.82	1.221	0.82	1.487	1.00	1.00	1.487	No
263	43.31	2.69	1.20	1.49	0.82	1.219	0.82	1.485	1.00	1.00	1.485	No
264	43.47	2.70	1.20	1.50	0.82	1.217	0.82	1.483	1.00	1.00	1.483	No
265	43.64	2.71	1.21	1.50	0.82	1.216	0.82	1.481	1.00	1.00	1.481	No
266	43.80	2.72	1.21	1.51	0.82	1.214	0.82	1.479	1.00	1.00	1.479	No
267	43.97	2.73	1.22	1.51	0.81	1.213	0.82	1.477	1.00	1.00	1.477	No
268	44.13	2.74	1.22	1.51	0.81	1.211	0.82	1.475	1.00	1.00	1.475	No
269	44.29	2.74	1.23	1.52	0.81	1.209	0.82	1.473	1.00	1.00	1.473	No
270	44.46	2.75	1.23	1.52	0.81	1.208	0.82	1.471	1.00	1.00	1.471	No
271	44.62	2.76	1.24	1.53	0.81	1.206	0.82	1.469	1.00	1.00	1.469	No
272	44.79	2.77	1.24	1.53	0.81	1.204	0.82	1.467	1.00	1.00	1.467	No
273	44.95	2.78	1.25	1.54	0.80	1.203	0.82	1.465	1.00	1.00	1.465	No
274	45.11	2.79	1.25	1.54	0.80	1.201	0.82	1.463	1.00	1.00	2.000	Yes
275	45.28	2.80	1.26	1.55	0.80	1.199	0.82	1.460	1.00	1.00	2.000	Yes
276	45.44	2.81	1.26	1.55	0.80	1.197	0.82	1.458	1.00	1.00	2.000	Yes
277	45.61	2.82	1.27	1.56	0.80	1.194	0.82	1.455	1.00	1.00	2.000	Yes
278	45.77	2.83	1.27	1.56	0.80	1.192	0.82	1.452	1.00	1.00	2.000	Yes
279	45.93	2.84	1.28	1.57	0.79	1.190	0.82	1.449	1.00	1.00	2.000	Yes
280	46.10	2.86	1.28	1.57	0.79	1.187	0.82	1.446	1.00	1.00	1.446	No
281	46.26	2.87	1.29	1.58	0.79	1.185	0.82	1.443	1.00	1.00	1.443	No
282	46.43	2.88	1.29	1.59	0.79	1.182	0.82	1.440	1.00	1.00	1.440	No
283	46.59	2.89	1.30	1.59	0.79	1.180	0.82	1.438	1.00	1.00	1.438	No
284	46.75	2.90	1.30	1.60	0.79	1.178	0.82	1.435	1.00	1.00	1.435	No
285	46.92	2.91	1.31	1.60	0.78	1.175	0.82	1.432	1.00	1.00	1.432	No
286	47.08	2.92	1.31	1.61	0.78	1.173	0.82	1.429	1.00	1.00	1.429	No
287	47.25	2.93	1.32	1.62	0.78	1.170	0.82	1.426	1.00	1.00	1.426	No
288	47.41	2.94	1.32	1.62	0.78	1.168	0.82	1.423	1.00	1.00	1.423	No

:: Cyclic Stress Ratio fully adjusted (CSR*) calculation data :: (continued)

Point ID	Depth (ft)	σ_v (tsf)	u_0 (tsf)	σ_v' (tsf)	r_d	CSR	MSF	CSR_{eq}	K_σ	User FS	CSR^*	Belongs to transition
289	47.57	2.96	1.33	1.63	0.78	1.166	0.82	1.420	1.00	1.00	1.420	No
290	47.74	2.97	1.33	1.63	0.78	1.163	0.82	1.417	1.00	1.00	1.417	No
291	47.90	2.98	1.34	1.64	0.77	1.161	0.82	1.414	1.00	1.00	1.414	No
292	48.07	2.99	1.34	1.65	0.77	1.158	0.82	1.411	1.00	1.00	1.411	No
293	48.23	3.00	1.35	1.65	0.77	1.156	0.82	1.408	1.00	1.00	1.408	No
294	48.39	3.01	1.35	1.66	0.77	1.153	0.82	1.405	1.00	1.00	1.405	No
295	48.56	3.02	1.36	1.66	0.77	1.151	0.82	1.402	1.00	1.00	1.402	No
296	48.72	3.03	1.36	1.67	0.77	1.148	0.82	1.399	1.00	1.00	1.399	No
297	48.89	3.05	1.37	1.68	0.76	1.146	0.82	1.396	1.00	1.00	1.396	No
298	49.05	3.06	1.37	1.68	0.76	1.143	0.82	1.393	1.00	1.00	1.393	No
299	49.22	3.07	1.38	1.69	0.76	1.141	0.82	1.390	1.00	1.00	1.390	No
300	49.38	3.08	1.38	1.69	0.76	1.139	0.82	1.387	1.00	1.00	1.387	No
301	49.54	3.09	1.39	1.70	0.76	1.136	0.82	1.384	1.00	1.00	1.384	No
302	49.71	3.10	1.39	1.71	0.76	1.134	0.82	1.381	1.00	1.00	1.381	No
303	49.87	3.11	1.40	1.71	0.75	1.132	0.82	1.379	1.00	1.00	1.379	No

Abbreviations

Depth:	Depth from free surface, at which CPT was performed (ft)
σ_v :	Total overburden pressure at test point (tsf)
u_0 :	Water pressure at test point (tsf)
σ_v' :	Effective overburden pressure based on GWT during earthquake (tsf)
r_d :	Nonlinear shear mass factor
CSR:	Cyclic Stress Ratio
MSF:	Magnitude Scaling Factor
CSR_{eq} :	CSR adjusted for M=7.5
K_σ :	Effective overburden stress factor
CSR^* :	CSR fully adjusted

:: Cyclic Resistance Ratio (CRR) calculation data ::												
Point ID	Depth (ft)	q_t (tsf)	I_c	Fr (%)	n	Q_{tn}	K_c	$Q_{tn,cs}$	CRR _{7.5}	Belongs to trans. layer	Clay-like behaviour	FS
1	0.33	135.57	1.16	0.17	0.29	256.22	1.00	256.22	4.000	No	No	2.00
2	0.49	123.74	1.21	0.19	0.31	233.83	1.00	233.83	4.000	No	No	2.00
3	0.66	108.50	1.26	0.18	0.33	205.02	1.00	205.02	4.000	No	No	2.00
4	0.82	98.03	1.28	0.17	0.34	185.22	1.00	185.22	4.000	No	No	2.00
5	0.98	89.50	1.34	0.19	0.36	169.07	1.00	169.07	4.000	No	No	2.00
6	1.15	81.03	1.42	0.25	0.40	153.05	1.00	153.05	4.000	No	No	2.00
7	1.31	72.13	1.49	0.28	0.42	136.21	1.00	136.21	4.000	No	No	2.00
8	1.48	64.20	1.56	0.31	0.45	121.20	1.00	121.20	4.000	No	No	2.00
9	1.64	58.10	1.54	0.23	0.44	109.65	1.00	109.65	4.000	No	No	2.00
10	1.80	53.50	1.50	0.12	0.43	100.94	1.00	100.94	4.000	No	No	2.00
11	1.97	49.40	4.06	0.00	1.00	93.18	26.61	2479.06	4.000	No	Yes	2.00
12	2.13	45.37	4.06	0.00	1.00	85.54	26.61	2275.90	4.000	No	Yes	2.00
13	2.30	41.10	4.06	0.00	1.00	77.46	26.61	2060.99	4.000	No	Yes	2.00
14	2.46	37.34	4.06	0.00	1.00	70.33	26.61	1871.24	4.000	No	Yes	2.00
15	2.62	34.40	4.06	0.00	1.00	64.77	26.61	1723.37	4.000	No	Yes	2.00
16	2.79	32.67	4.06	0.00	1.00	61.48	26.61	1635.83	4.000	No	Yes	2.00
17	2.95	32.50	4.06	0.00	1.00	61.16	26.61	1627.10	4.000	No	Yes	2.00
18	3.12	36.50	1.64	0.09	0.48	68.70	1.00	68.70	4.000	No	No	2.00
19	3.28	44.90	1.59	0.15	0.46	84.56	1.00	84.56	4.000	No	No	2.00
20	3.45	53.00	1.51	0.13	0.43	99.86	1.00	99.86	4.000	No	No	2.00
21	3.61	52.97	1.47	0.06	0.42	99.78	1.00	99.78	4.000	No	No	2.00
22	3.77	47.50	1.52	0.07	0.44	89.43	1.00	89.43	4.000	No	No	2.00
23	3.94	40.83	1.64	0.16	0.49	76.81	1.00	76.81	4.000	No	No	2.00
24	4.10	36.80	1.81	0.36	0.55	69.17	1.00	69.17	4.000	No	No	2.00
25	4.27	30.60	2.00	0.66	0.62	57.44	1.30	74.76	4.000	No	No	2.00
26	4.43	25.14	2.27	1.47	0.73	47.09	1.86	87.49	4.000	No	No	2.00
27	4.59	22.84	2.40	2.06	0.77	42.73	2.29	98.03	4.000	No	No	2.00
28	4.76	23.77	2.41	2.27	0.78	44.48	2.35	104.41	4.000	No	No	2.00
29	4.92	24.53	2.35	1.92	0.76	45.90	2.13	97.58	4.000	No	No	2.00
30	5.09	23.59	2.38	2.00	0.77	44.10	2.22	97.81	0.167	No	No	0.17
31	5.25	22.82	2.40	2.07	0.78	42.62	2.30	98.05	0.168	No	No	0.16
32	5.41	21.79	2.45	2.32	0.79	40.66	2.51	101.91	0.178	No	No	0.17
33	5.58	20.56	2.50	2.63	0.82	38.32	2.77	106.05	0.191	No	No	0.18
34	5.74	20.06	2.52	2.70	0.82	37.36	3.11	116.02	4.000	Yes	No	2.00
35	5.91	22.66	2.42	2.24	0.79	42.26	2.40	101.53	4.000	Yes	No	2.00
36	6.07	32.40	2.14	1.25	0.68	60.64	1.53	92.86	4.000	Yes	No	2.00
37	6.23	49.74	1.80	0.61	0.55	93.40	1.11	103.66	4.000	Yes	No	2.00
38	6.40	73.47	1.58	0.36	0.46	126.12	1.00	126.12	0.267	No	No	0.23
39	6.56	101.60	1.44	0.30	0.41	162.05	1.00	162.05	0.476	No	No	0.41
40	6.73	130.66	1.38	0.33	0.39	201.72	1.00	201.72	4.000	No	No	2.00
41	6.89	158.33	1.35	0.38	0.38	239.81	1.00	239.81	4.000	No	No	2.00
42	7.05	183.20	1.35	0.46	0.38	276.19	1.00	276.19	4.000	No	No	2.00
43	7.22	206.67	1.35	0.52	0.38	309.75	1.00	309.75	4.000	No	No	2.00
44	7.38	228.67	1.35	0.57	0.38	340.85	1.00	340.85	4.000	No	No	2.00
45	7.55	241.87	1.36	0.61	0.38	359.15	1.00	359.15	4.000	No	No	2.00
46	7.71	243.48	1.38	0.66	0.39	363.14	1.00	363.14	4.000	No	No	2.00
47	7.87	236.94	1.40	0.69	0.40	354.79	1.00	354.79	4.000	No	No	2.00
48	8.04	235.88	1.42	0.74	0.41	354.26	1.00	354.26	4.000	No	No	2.00

:: Cyclic Resistance Ratio (CRR) calculation data :: (continued)												
Point ID	Depth (ft)	q_t (tsf)	I_c	Fr (%)	n	Q_{tn}	K_c	$Q_{tn,cs}$	CRR _{7.5}	Belongs to trans. layer	Clay-like behaviour	FS
49	8.20	242.08	1.46	0.84	0.42	366.90	1.00	366.90	4.000	No	No	2.00
50	8.37	248.81	1.51	0.99	0.44	382.06	1.00	382.06	4.000	No	No	2.00
51	8.53	251.81	1.55	1.15	0.46	391.68	1.00	391.68	4.000	No	No	2.00
52	8.69	258.50	1.57	1.23	0.46	401.97	1.00	401.97	4.000	No	No	2.00
53	8.86	271.36	1.55	1.19	0.46	415.85	1.00	415.85	4.000	No	No	2.00
54	9.02	283.19	1.52	1.11	0.45	425.59	1.00	425.59	4.000	No	No	2.00
55	9.19	288.75	1.49	1.02	0.43	425.84	1.00	425.84	4.000	No	No	2.00
56	9.35	287.35	1.47	0.95	0.43	418.14	1.00	418.14	4.000	No	No	2.00
57	9.51	277.55	1.43	0.82	0.41	395.60	1.00	395.60	4.000	No	No	2.00
58	9.68	261.02	1.41	0.73	0.41	367.26	1.00	367.26	4.000	No	No	2.00
59	9.84	246.82	1.41	0.69	0.41	345.36	1.00	345.36	4.000	No	No	2.00
60	10.01	216.09	1.54	0.96	0.46	315.74	1.00	315.74	4.000	No	No	2.00
61	10.17	164.82	1.74	1.44	0.53	256.64	1.06	273.17	4.000	No	No	2.00
62	10.34	101.32	2.04	2.55	0.65	174.00	1.35	235.57	4.000	No	No	2.00
63	10.50	61.70	2.30	3.98	0.75	114.78	1.96	224.59	4.000	No	No	2.00
64	10.66	64.68	2.26	3.64	0.73	117.78	1.84	216.86	4.000	No	No	2.00
65	10.83	93.42	2.06	2.48	0.65	157.36	1.38	217.17	4.000	No	No	2.00
66	10.99	138.66	1.83	1.64	0.57	215.34	1.13	243.34	4.000	No	No	2.00
67	11.16	179.78	1.65	1.12	0.50	261.21	1.00	261.72	4.000	No	No	2.00
68	11.32	212.75	1.53	0.86	0.45	295.71	1.00	295.71	4.000	No	No	2.00
69	11.48	232.58	1.47	0.78	0.43	316.13	1.00	316.13	4.000	No	No	2.00
70	11.65	243.88	1.48	0.82	0.44	330.51	1.00	330.51	4.000	No	No	2.00
71	11.81	253.11	1.48	0.83	0.43	340.89	1.00	340.89	4.000	No	No	2.00
72	11.98	261.41	1.47	0.83	0.43	349.52	1.00	349.52	4.000	No	No	2.00
73	12.14	263.97	1.46	0.82	0.43	350.84	1.00	350.84	4.000	No	No	2.00
74	12.30	258.91	1.48	0.84	0.44	343.74	1.00	343.74	4.000	No	No	2.00
75	12.47	244.80	1.52	0.93	0.45	327.89	1.00	327.89	4.000	No	No	2.00
76	12.63	219.57	1.64	1.23	0.50	302.84	1.00	302.18	4.000	No	No	2.00
77	12.80	173.43	1.82	1.80	0.57	250.24	1.12	281.12	4.000	No	No	2.00
78	12.96	122.50	2.04	2.66	0.65	186.25	1.35	251.29	4.000	No	No	2.00
79	13.12	77.87	2.28	3.98	0.74	125.40	1.88	236.03	4.000	No	No	2.00
80	13.29	58.51	2.43	5.02	0.80	97.03	2.43	235.33	4.000	No	No	2.00
81	13.45	58.19	2.43	4.99	0.80	95.76	2.43	232.86	4.000	No	No	2.00
82	13.62	77.37	2.25	3.53	0.73	120.69	1.79	216.15	4.000	No	No	2.00
83	13.78	98.77	2.06	2.35	0.66	145.87	1.38	201.86	4.000	No	No	2.00
84	13.94	119.39	1.89	1.60	0.60	168.07	1.18	198.52	0.808	No	No	0.54
85	14.11	133.38	1.80	1.31	0.56	182.56	1.11	202.29	4.000	No	No	2.00
86	14.27	156.65	1.72	1.13	0.53	208.95	1.05	219.20	4.000	No	No	2.00
87	14.44	180.24	1.61	0.89	0.49	232.99	1.00	232.99	4.000	No	No	2.00
88	14.60	200.81	1.53	0.77	0.46	253.97	1.00	253.97	4.000	No	No	2.00
89	14.76	209.81	1.51	0.73	0.45	262.78	1.00	262.78	4.000	No	No	2.00
90	14.93	210.34	1.55	0.83	0.47	264.57	1.00	264.57	4.000	No	No	2.00
91	15.09	209.57	1.57	0.88	0.47	263.74	1.00	263.74	4.000	No	No	2.00
92	15.26	209.00	1.58	0.91	0.48	262.67	1.00	262.67	4.000	No	No	2.00
93	15.42	210.37	1.59	0.95	0.48	264.06	1.00	264.06	4.000	No	No	2.00
94	15.58	206.87	1.61	0.99	0.49	259.46	1.00	259.46	4.000	No	No	2.00
95	15.75	201.03	1.65	1.10	0.51	253.29	1.00	254.42	4.000	No	No	2.00
96	15.91	199.30	1.70	1.28	0.53	252.74	1.04	262.71	4.000	No	No	2.00

:: Cyclic Resistance Ratio (CRR) calculation data :: (continued)												
Point ID	Depth (ft)	q _t (tsf)	I _c	Fr (%)	n	Q _{tn}	K _c	Q _{tn,cs}	CRR _{7.5}	Belongs to trans. layer	Clay-like behaviour	FS
97	16.08	204.33	1.72	1.38	0.53	258.91	1.05	272.45	4.000	No	No	2.00
98	16.24	210.83	1.70	1.32	0.53	264.77	1.04	274.91	4.000	No	No	2.00
99	16.40	213.07	1.67	1.21	0.52	264.78	1.02	269.65	4.000	No	No	2.00
100	16.57	216.03	1.63	1.09	0.50	265.24	1.00	265.24	4.000	No	No	2.00
101	16.73	226.60	1.59	0.99	0.49	274.88	1.00	274.88	4.000	No	No	2.00
102	16.90	248.93	1.54	0.91	0.47	297.92	1.00	297.92	4.000	No	No	2.00
103	17.06	276.60	1.51	0.90	0.46	327.76	1.00	327.76	4.000	No	No	2.00
104	17.23	305.37	1.49	0.91	0.45	359.18	1.00	359.18	4.000	No	No	2.00
105	17.39	327.61	1.47	0.89	0.44	382.24	1.00	382.24	4.000	No	No	2.00
106	17.55	338.18	1.45	0.86	0.43	391.91	1.00	391.91	4.000	No	No	2.00
107	17.72	339.98	1.44	0.84	0.43	391.82	1.00	391.82	4.000	No	No	2.00
108	17.88	335.51	1.41	0.76	0.42	383.44	1.00	383.44	4.000	No	No	2.00
109	18.05	328.54	1.39	0.70	0.41	372.99	1.00	372.99	4.000	No	No	2.00
110	18.21	310.14	1.40	0.67	0.41	350.97	1.00	350.97	4.000	No	No	2.00
111	18.37	273.60	1.49	0.81	0.45	313.34	1.00	313.34	4.000	No	No	2.00
112	18.54	213.40	1.66	1.10	0.51	249.88	1.01	251.65	4.000	No	No	2.00
113	18.70	143.36	1.87	1.55	0.60	172.69	1.16	201.00	4.000	No	No	2.00
114	18.87	83.22	2.15	2.27	0.70	103.57	1.54	159.81	0.460	No	No	0.29
115	19.03	47.96	2.40	3.13	0.80	61.19	2.33	142.44	0.349	No	No	0.22
116	19.19	48.50	2.37	2.82	0.79	61.25	2.20	134.52	0.306	No	No	0.20
117	19.36	79.29	2.03	1.45	0.66	95.54	1.34	128.39	0.277	No	No	0.18
118	19.52	128.27	1.72	0.81	0.54	147.89	1.05	155.74	0.431	No	No	0.27
119	19.69	174.50	1.55	0.62	0.48	196.02	1.00	196.02	0.780	No	No	0.50
120	19.85	204.93	1.51	0.64	0.46	228.42	1.00	228.42	4.000	No	No	2.00
121	20.01	219.00	1.53	0.73	0.47	244.14	1.00	244.14	4.000	No	No	2.00
122	20.18	221.39	1.55	0.79	0.48	246.59	1.00	246.59	4.000	No	No	2.00
123	20.34	221.29	1.55	0.77	0.47	245.51	1.00	245.51	4.000	No	No	2.00
124	20.51	216.66	1.61	0.93	0.50	241.47	1.00	241.47	4.000	No	No	2.00
125	20.67	193.02	1.74	1.25	0.55	217.72	1.06	231.39	4.000	No	No	2.00
126	20.83	149.15	1.93	1.80	0.62	171.25	1.21	207.86	4.000	No	No	2.00
127	21.00	114.32	2.00	1.80	0.65	131.54	1.30	171.02	0.545	No	No	0.34
128	21.16	123.76	1.83	1.12	0.59	139.14	1.13	157.64	0.444	No	No	0.28
129	21.33	166.36	1.59	0.65	0.49	181.53	1.00	181.53	0.636	No	No	0.40
130	21.49	212.19	1.50	0.62	0.46	228.84	1.00	228.84	4.000	No	No	2.00
131	21.65	236.15	1.49	0.65	0.45	253.64	1.00	253.64	4.000	No	No	2.00
132	21.82	245.45	1.49	0.68	0.45	262.93	1.00	262.93	4.000	No	No	2.00
133	21.98	246.45	1.49	0.69	0.46	263.36	1.00	263.36	4.000	No	No	2.00
134	22.15	241.32	1.52	0.75	0.47	257.86	1.00	257.86	4.000	No	No	2.00
135	22.31	232.35	1.57	0.84	0.49	248.61	1.00	248.61	4.000	No	No	2.00
136	22.47	222.78	1.57	0.81	0.49	237.68	1.00	237.68	4.000	No	No	2.00
137	22.64	208.51	1.60	0.82	0.50	222.14	1.00	222.14	4.000	No	No	2.00
138	22.80	180.94	1.66	0.89	0.52	193.22	1.01	195.83	0.778	No	No	0.49
139	22.97	139.37	1.84	1.23	0.59	150.40	1.14	171.12	0.546	No	No	0.34
140	23.13	94.70	2.04	1.61	0.67	103.17	1.35	139.65	0.333	No	No	0.21
141	23.30	63.68	2.25	2.14	0.75	69.84	1.79	124.96	0.261	No	No	0.16
142	23.46	58.35	2.27	2.11	0.76	63.72	1.86	118.49	0.235	No	No	0.15
143	23.62	59.63	2.27	2.18	0.76	64.89	1.87	121.38	0.246	No	No	0.15
144	23.79	71.93	2.15	1.75	0.71	77.48	1.56	120.95	0.245	No	No	0.15

:: Cyclic Resistance Ratio (CRR) calculation data :: (continued)												
Point ID	Depth (ft)	q_t (tsf)	I_c	Fr (%)	n	Q_{tn}	K_c	$Q_{tn,cs}$	CRR _{7.5}	Belongs to trans. layer	Clay-like behaviour	FS
145	23.95	84.80	2.04	1.40	0.67	90.43	1.35	122.47	0.251	No	No	0.16
146	24.12	107.23	1.86	0.98	0.60	112.78	1.16	130.44	0.286	No	No	0.18
147	24.28	125.69	1.72	0.70	0.55	130.65	1.05	137.51	0.322	No	No	0.20
148	24.44	137.62	1.64	0.56	0.51	141.90	1.00	141.90	0.346	No	No	0.22
149	24.61	145.95	1.59	0.51	0.50	149.67	1.00	149.67	0.392	No	No	0.24
150	24.77	150.78	1.61	0.56	0.50	154.41	1.00	154.41	0.422	No	No	0.26
151	24.94	156.38	1.62	0.62	0.51	159.92	1.00	159.92	0.460	No	No	0.29
152	25.10	172.48	1.62	0.68	0.51	175.96	1.00	175.96	0.587	No	No	0.36
153	25.26	199.12	1.58	0.71	0.49	202.36	1.00	202.36	4.000	No	No	2.00
154	25.43	232.85	1.54	0.72	0.48	235.60	1.00	235.60	4.000	No	No	2.00
155	25.59	262.96	1.50	0.71	0.46	264.93	1.00	264.93	4.000	No	No	2.00
156	25.76	285.33	1.47	0.69	0.45	286.26	1.00	286.26	4.000	No	No	2.00
157	25.92	293.63	1.46	0.70	0.45	293.76	1.00	293.76	4.000	No	No	2.00
158	26.08	283.63	1.52	0.80	0.47	283.75	1.00	283.75	4.000	No	No	2.00
159	26.25	258.42	1.62	1.01	0.51	258.89	1.00	258.89	4.000	No	No	2.00
160	26.41	226.49	1.73	1.26	0.55	227.15	1.06	239.93	4.000	No	No	2.00
161	26.58	201.69	1.81	1.45	0.58	202.10	1.11	224.63	4.000	No	No	2.00
162	26.74	202.22	1.82	1.53	0.59	202.10	1.12	227.32	4.000	No	No	2.00
163	26.90	230.86	1.76	1.41	0.57	229.59	1.08	247.94	4.000	No	No	2.00
164	27.07	270.13	1.67	1.23	0.53	267.11	1.02	272.56	4.000	No	No	2.00
165	27.23	281.80	1.68	1.29	0.54	277.88	1.02	284.43	4.000	No	No	2.00
166	27.40	243.10	1.78	1.52	0.57	239.44	1.09	260.87	4.000	No	No	2.00
167	27.56	175.29	1.97	2.07	0.65	172.62	1.26	218.01	4.000	No	No	2.00
168	27.72	142.96	2.03	2.10	0.67	140.20	1.34	188.47	0.703	No	No	0.44
169	27.89	162.20	1.90	1.56	0.62	158.13	1.19	188.02	0.698	No	No	0.43
170	28.05	208.90	1.70	1.06	0.55	202.53	1.04	210.86	4.000	No	No	2.00
171	28.22	246.56	1.57	0.82	0.50	237.93	1.00	237.93	4.000	No	No	2.00
172	28.38	270.62	1.50	0.71	0.47	260.26	1.00	260.26	4.000	No	No	2.00
173	28.54	281.86	1.49	0.70	0.46	270.39	1.00	270.39	4.000	No	No	2.00
174	28.71	253.29	1.60	0.91	0.51	242.60	1.00	242.60	4.000	No	No	2.00
175	28.87	186.05	1.81	1.30	0.59	177.74	1.11	197.80	4.000	Yes	No	2.00
176	29.04	110.01	2.09	1.94	0.70	104.39	1.44	150.53	4.000	Yes	No	2.00
177	29.20	54.94	2.39	2.51	0.81	51.25	2.28	116.83	4.000	Yes	No	2.00
178	29.36	31.58	2.58	2.46	0.88	28.66	4.70	134.64	4.000	Yes	No	2.00
179	29.53	23.76	2.71	2.73	0.93	21.07	4.08	85.94	4.000	Yes	Yes	2.00
180	29.69	24.90	2.79	3.90	0.96	22.07	4.72	104.26	4.000	Yes	Yes	2.00
181	29.86	57.31	2.41	2.76	0.82	52.74	2.36	124.47	4.000	Yes	No	2.00
182	30.02	86.82	2.23	2.35	0.75	80.45	1.75	140.66	4.000	Yes	No	2.00
183	30.19	106.27	2.14	2.11	0.71	98.47	1.52	150.10	4.000	Yes	No	2.00
184	30.35	87.47	2.20	2.14	0.74	80.45	1.67	134.64	4.000	Yes	No	2.00
185	30.51	66.58	2.28	2.06	0.77	60.58	1.89	114.38	4.000	Yes	No	2.00
186	30.68	53.12	2.35	2.02	0.80	47.78	2.13	101.60	4.000	Yes	No	2.00
187	30.84	43.66	2.53	2.95	0.86	38.77	3.41	132.01	4.000	Yes	No	2.00
188	31.01	37.39	2.70	4.32	0.93	32.75	9.89	323.71	4.000	Yes	No	2.00
189	31.17	32.34	2.80	5.15	0.97	27.93	4.77	133.10	4.000	Yes	Yes	2.00
190	31.33	27.94	2.84	4.99	0.98	23.78	5.13	122.05	1.134	No	Yes	0.71
191	31.50	24.67	2.84	4.25	0.98	20.69	5.12	105.96	0.987	No	Yes	0.61
192	31.66	21.21	2.88	3.98	1.00	17.46	5.47	95.55	0.833	No	Yes	0.52

:: Cyclic Resistance Ratio (CRR) calculation data :: (continued)												
Point ID	Depth (ft)	q _t (tsf)	I _c	Fr (%)	n	Q _{tn}	K _c	Q _{tn,cs}	CRR _{7.5}	Belongs to trans. layer	Clay-like behaviour	FS
193	31.83	21.50	2.84	3.58	0.99	17.65	5.17	91.29	0.842	No	Yes	0.52
194	31.99	21.88	2.83	3.51	0.98	17.92	5.08	91.03	0.855	No	Yes	0.53
195	32.15	24.16	2.74	2.85	0.95	19.93	4.31	85.91	0.951	No	Yes	0.59
196	32.32	27.77	2.68	2.71	0.92	23.10	8.87	204.89	4.000	No	No	2.00
197	32.48	30.05	2.71	3.33	0.93	25.03	4.04	101.21	4.000	Yes	Yes	2.00
198	32.65	43.56	2.56	3.13	0.88	37.05	4.19	155.11	4.000	Yes	No	2.00
199	32.81	72.79	2.31	2.35	0.78	63.28	1.97	124.59	4.000	Yes	No	2.00
200	32.97	124.71	2.03	1.66	0.68	110.18	1.34	147.37	4.000	Yes	No	2.00
201	33.14	173.48	1.89	1.46	0.62	154.10	1.18	181.28	4.000	Yes	No	2.00
202	33.30	210.16	1.83	1.44	0.60	186.85	1.13	210.54	4.000	Yes	No	2.00
203	33.47	225.85	1.81	1.47	0.60	200.40	1.12	223.93	4.000	No	No	2.00
204	33.63	230.03	1.76	1.27	0.58	203.94	1.08	220.08	4.000	No	No	2.00
205	33.79	226.85	1.72	1.11	0.56	200.84	1.05	211.43	4.000	No	No	2.00
206	33.96	219.63	1.66	0.87	0.54	194.36	1.01	195.91	0.779	No	No	0.49
207	34.12	204.19	1.68	0.86	0.54	179.99	1.02	183.74	0.657	No	No	0.41
208	34.29	172.47	1.76	0.96	0.58	150.76	1.08	163.03	0.483	No	No	0.30
209	34.45	126.17	2.00	1.48	0.67	108.36	1.30	140.54	0.338	No	No	0.21
210	34.61	87.99	2.30	2.72	0.78	73.72	1.96	144.38	0.360	No	No	0.23
211	34.78	121.60	2.17	2.43	0.73	102.86	1.59	163.81	0.489	No	No	0.31
212	34.94	190.92	1.95	1.87	0.65	163.75	1.24	203.09	4.000	No	No	2.00
213	35.11	273.91	1.79	1.58	0.59	236.89	1.10	260.93	4.000	No	No	2.00
214	35.27	312.31	1.77	1.61	0.58	269.97	1.08	292.13	4.000	No	No	2.00
215	35.43	345.04	1.75	1.64	0.57	297.89	1.07	318.66	4.000	No	No	2.00
216	35.60	373.91	1.72	1.61	0.56	322.50	1.05	338.94	4.000	No	No	2.00
217	35.76	401.69	1.68	1.53	0.55	346.36	1.03	355.75	4.000	No	No	2.00
218	35.93	423.86	1.65	1.42	0.54	365.39	1.00	365.52	4.000	No	No	2.00
219	36.09	434.89	1.62	1.34	0.53	374.61	1.00	374.61	4.000	No	No	2.00
220	36.26	433.91	1.60	1.28	0.52	373.11	1.00	373.11	4.000	No	No	2.00
221	36.42	425.54	1.61	1.29	0.52	364.73	1.00	364.73	4.000	No	No	2.00
222	36.58	417.10	1.62	1.30	0.53	356.34	1.00	356.34	4.000	No	No	2.00
223	36.75	409.16	1.62	1.29	0.53	348.54	1.00	348.54	4.000	No	No	2.00
224	36.91	402.13	1.61	1.24	0.53	341.83	1.00	341.83	4.000	No	No	2.00
225	37.08	399.46	1.60	1.17	0.52	339.10	1.00	339.10	4.000	No	No	2.00
226	37.24	403.32	1.59	1.16	0.52	341.76	1.00	341.76	4.000	No	No	2.00
227	37.40	410.39	1.58	1.15	0.51	347.07	1.00	347.07	4.000	No	No	2.00
228	37.57	415.96	1.59	1.18	0.52	350.70	1.00	350.70	4.000	No	No	2.00
229	37.73	423.66	1.59	1.20	0.52	356.32	1.00	356.32	4.000	No	No	2.00
230	37.90	432.63	1.60	1.23	0.52	362.83	1.00	362.83	4.000	No	No	2.00
231	38.06	442.83	1.60	1.25	0.52	370.54	1.00	370.54	4.000	No	No	2.00
232	38.22	447.40	1.60	1.26	0.52	373.46	1.00	373.46	4.000	No	No	2.00
233	38.39	450.87	1.59	1.25	0.52	375.53	1.00	375.53	4.000	No	No	2.00
234	38.55	457.33	1.59	1.25	0.52	380.16	1.00	380.16	4.000	No	No	2.00
235	38.72	467.74	1.58	1.25	0.52	388.03	1.00	388.03	4.000	No	No	2.00
236	38.88	477.07	1.58	1.24	0.52	395.07	1.00	395.07	4.000	No	No	2.00
237	39.04	477.51	1.57	1.22	0.51	394.73	1.00	394.73	4.000	No	No	2.00
238	39.21	466.07	1.57	1.18	0.51	384.50	1.00	384.50	4.000	No	No	2.00
239	39.37	445.73	1.56	1.14	0.51	366.84	1.00	366.84	4.000	No	No	2.00
240	39.54	437.63	1.54	1.05	0.50	360.09	1.00	360.09	4.000	No	No	2.00

:: Cyclic Resistance Ratio (CRR) calculation data :: (continued)												
Point ID	Depth (ft)	q_t (tsf)	I_c	Fr (%)	n	Q_{tn}	K_c	$Q_{tn,cs}$	CRR _{7.5}	Belongs to trans. layer	Clay-like behaviour	FS
241	39.70	442.56	1.52	1.01	0.50	363.99	1.00	363.99	4.000	No	No	2.00
242	39.86	451.63	1.51	0.99	0.49	371.14	1.00	371.14	4.000	No	No	2.00
243	40.03	442.29	1.52	0.99	0.49	362.38	1.00	362.38	4.000	No	No	2.00
244	40.19	419.98	1.51	0.92	0.49	343.63	1.00	343.63	4.000	No	No	2.00
245	40.36	390.70	1.48	0.79	0.48	319.89	1.00	319.89	4.000	No	No	2.00
246	40.52	355.55	1.47	0.72	0.48	290.44	1.00	290.44	4.000	No	No	2.00
247	40.68	308.43	1.53	0.75	0.50	249.50	1.00	249.50	4.000	No	No	2.00
248	40.85	248.67	1.70	1.02	0.56	196.59	1.04	204.00	4.000	No	No	2.00
249	41.01	182.39	1.92	1.48	0.65	139.72	1.21	168.96	4.000	Yes	No	2.00
250	41.18	120.38	2.17	2.12	0.75	88.68	1.60	141.59	4.000	Yes	No	2.00
251	41.34	74.75	2.40	2.63	0.83	52.75	2.30	121.33	4.000	Yes	No	2.00
252	41.50	49.40	2.54	2.63	0.89	33.53	3.76	126.13	4.000	Yes	No	2.00
253	41.67	37.80	2.62	2.37	0.92	24.93	5.97	148.80	4.000	Yes	No	2.00
254	41.83	31.66	2.68	2.29	0.94	20.36	8.85	180.20	4.000	Yes	No	2.00
255	42.00	27.42	2.77	2.55	0.97	17.15	4.49	77.09	4.000	Yes	Yes	2.00
256	42.16	25.53	2.80	2.62	0.99	15.71	4.81	75.51	0.750	No	Yes	0.50
257	42.32	24.65	2.81	2.57	0.99	15.04	4.90	73.69	0.718	No	Yes	0.48
258	42.49	24.27	2.81	2.47	0.99	14.74	4.87	71.76	0.703	No	Yes	0.47
259	42.65	24.77	2.80	2.41	0.99	15.05	4.76	71.62	0.718	No	Yes	0.48
260	42.82	25.96	2.78	2.43	0.98	15.84	4.62	73.25	0.756	No	Yes	0.51
261	42.98	27.45	2.77	2.56	0.98	16.83	4.55	76.59	0.803	No	Yes	0.54
262	43.15	28.30	2.77	2.60	0.97	17.36	4.50	78.12	0.828	No	Yes	0.56
263	43.31	28.29	2.78	2.73	0.98	17.26	4.62	79.76	0.823	No	Yes	0.55
264	43.47	27.71	2.78	2.67	0.98	16.81	4.64	78.05	0.802	No	Yes	0.54
265	43.64	26.93	2.78	2.48	0.98	16.25	4.59	74.53	0.775	No	Yes	0.52
266	43.80	26.10	2.77	2.28	0.98	15.65	4.53	70.87	0.747	No	Yes	0.50
267	43.97	25.74	2.78	2.32	0.98	15.34	4.62	70.85	0.732	No	Yes	0.50
268	44.13	26.04	2.79	2.43	0.98	15.47	4.69	72.61	0.738	No	Yes	0.50
269	44.29	27.10	2.78	2.46	0.98	16.15	4.59	74.19	0.771	No	Yes	0.52
270	44.46	27.91	2.74	2.25	0.97	16.71	4.32	72.15	0.797	No	Yes	0.54
271	44.62	28.19	2.70	1.97	0.95	16.94	4.03	68.23	0.808	No	Yes	0.55
272	44.79	27.52	2.71	1.89	0.95	16.44	4.03	66.30	0.784	No	Yes	0.53
273	44.95	26.34	2.80	2.55	0.99	15.39	4.81	73.98	0.734	No	Yes	0.50
274	45.11	26.61	2.94	4.34	1.00	15.46	6.12	94.54	4.000	Yes	Yes	2.00
275	45.28	43.94	2.74	4.13	0.97	26.93	4.33	116.66	4.000	Yes	Yes	2.00
276	45.44	92.46	2.36	2.71	0.82	61.90	2.14	132.59	4.000	Yes	No	2.00
277	45.61	168.93	2.02	1.77	0.69	120.11	1.33	159.59	4.000	Yes	No	2.00
278	45.77	233.80	1.84	1.37	0.62	171.22	1.13	194.12	4.000	Yes	No	2.00
279	45.93	275.56	1.76	1.28	0.60	203.88	1.08	220.43	4.000	Yes	No	2.00
280	46.10	307.76	1.75	1.36	0.59	227.83	1.07	244.29	4.000	No	No	2.00
281	46.26	355.88	1.71	1.36	0.58	264.77	1.05	276.80	4.000	No	No	2.00
282	46.43	402.28	1.64	1.21	0.55	302.33	1.00	302.33	4.000	No	No	2.00
283	46.59	410.89	1.57	1.01	0.52	311.50	1.00	311.50	4.000	No	No	2.00
284	46.75	390.92	1.55	0.92	0.52	296.55	1.00	296.55	4.000	No	No	2.00
285	46.92	392.33	1.53	0.87	0.51	297.86	1.00	297.86	4.000	No	No	2.00
286	47.08	419.57	1.53	0.91	0.51	318.27	1.00	318.27	4.000	No	No	2.00
287	47.25	449.16	1.51	0.93	0.50	340.89	1.00	340.89	4.000	No	No	2.00
288	47.41	465.53	1.53	0.99	0.51	351.94	1.00	351.94	4.000	No	No	2.00

:: Cyclic Resistance Ratio (CRR) calculation data :: (continued)												
Point ID	Depth (ft)	q_t (tsf)	I_c	Fr (%)	n	Q_{tn}	K_c	$Q_{tn,cs}$	$CRR_{7.5}$	Belongs to trans. layer	Clay-like behaviour	FS
289	47.57	472.27	1.55	1.06	0.52	355.07	1.00	355.07	4.000	No	No	2.00
290	47.74	481.40	1.56	1.11	0.52	360.33	1.00	360.33	4.000	No	No	2.00
291	47.90	466.97	1.60	1.19	0.54	346.80	1.00	346.80	4.000	No	No	2.00
292	48.07	445.41	1.62	1.24	0.55	328.49	1.00	328.49	4.000	No	No	2.00
293	48.23	428.68	1.64	1.26	0.55	314.41	1.00	313.22	4.000	No	No	2.00
294	48.39	423.94	1.64	1.26	0.55	310.08	1.00	309.60	4.000	No	No	2.00
295	48.56	414.07	1.63	1.20	0.55	302.66	1.00	302.66	4.000	No	No	2.00
296	48.72	382.90	1.64	1.15	0.55	278.78	1.00	277.72	4.000	No	No	2.00
297	48.89	325.19	1.72	1.26	0.59	232.57	1.05	244.72	4.000	No	No	2.00
298	49.05	270.95	1.86	1.62	0.64	188.22	1.16	217.55	4.000	No	No	2.00
299	49.22	213.65	2.05	2.25	0.71	142.76	1.37	195.64	0.776	No	No	0.56
300	49.38	173.15	2.18	2.70	0.76	112.39	1.61	181.47	0.636	No	No	0.46
301	49.54	162.50	2.14	2.30	0.75	105.73	1.54	162.62	0.480	No	No	0.35
302	49.71	180.30	1.99	1.60	0.69	120.55	1.29	155.01	0.426	No	No	0.31
303	49.87	205.43	1.83	1.10	0.63	141.48	1.13	159.35	0.456	No	No	0.33

Abbreviations

Depth:	Depth from free surface, at which CPT was performed (ft)
q_t :	Total cone resistance
I_c :	Soil behavior type index
Fr:	Normalized friction ratio (%)
n:	Stress exponent
Q_{tn} :	Normalized cone resistance
K_c :	Cone resistance correction factor due to fines
$Q_{tn,cs}$:	Normalized and adjusted cone resistance
$CRR_{7.5}$:	Cyclic resistance ratio for $M_w=7.5$
FS:	Factor of safety against soil liquefaction

:: Liquefaction Potential Index calculation data ::											
Depth (ft)	FS	F_L	w_z	d_z	LPI	Depth (ft)	FS	F_L	w_z	d_z	LPI
0.33	2.00	0.00	9.95	0.16	0.00	0.49	2.00	0.00	9.93	0.16	0.00
0.66	2.00	0.00	9.90	0.17	0.00	0.82	2.00	0.00	9.88	0.16	0.00
0.98	2.00	0.00	9.85	0.16	0.00	1.15	2.00	0.00	9.82	0.17	0.00
1.31	2.00	0.00	9.80	0.16	0.00	1.48	2.00	0.00	9.77	0.17	0.00
1.64	2.00	0.00	9.75	0.16	0.00	1.80	2.00	0.00	9.73	0.16	0.00
1.97	2.00	0.00	9.70	0.17	0.00	2.13	2.00	0.00	9.68	0.16	0.00
2.30	2.00	0.00	9.65	0.17	0.00	2.46	2.00	0.00	9.63	0.16	0.00
2.62	2.00	0.00	9.60	0.16	0.00	2.79	2.00	0.00	9.57	0.17	0.00
2.95	2.00	0.00	9.55	0.16	0.00	3.12	2.00	0.00	9.52	0.17	0.00
3.28	2.00	0.00	9.50	0.16	0.00	3.45	2.00	0.00	9.47	0.17	0.00
3.61	2.00	0.00	9.45	0.16	0.00	3.77	2.00	0.00	9.43	0.16	0.00
3.94	2.00	0.00	9.40	0.17	0.00	4.10	2.00	0.00	9.38	0.16	0.00
4.27	2.00	0.00	9.35	0.17	0.00	4.43	2.00	0.00	9.32	0.16	0.00
4.59	2.00	0.00	9.30	0.16	0.00	4.76	2.00	0.00	9.27	0.17	0.00
4.92	2.00	0.00	9.25	0.16	0.00	5.09	0.17	0.83	9.22	0.17	0.40
5.25	0.16	0.84	9.20	0.16	0.38	5.41	0.17	0.83	9.18	0.16	0.37
5.58	0.18	0.82	9.15	0.17	0.39	5.74	2.00	0.00	9.13	0.16	0.00
5.91	2.00	0.00	9.10	0.17	0.00	6.07	2.00	0.00	9.07	0.16	0.00
6.23	2.00	0.00	9.05	0.16	0.00	6.40	0.23	0.77	9.02	0.17	0.36
6.56	0.41	0.59	9.00	0.16	0.26	6.73	2.00	0.00	8.97	0.17	0.00
6.89	2.00	0.00	8.95	0.16	0.00	7.05	2.00	0.00	8.93	0.16	0.00
7.22	2.00	0.00	8.90	0.17	0.00	7.38	2.00	0.00	8.88	0.16	0.00
7.55	2.00	0.00	8.85	0.17	0.00	7.71	2.00	0.00	8.82	0.16	0.00
7.87	2.00	0.00	8.80	0.16	0.00	8.04	2.00	0.00	8.77	0.17	0.00
8.20	2.00	0.00	8.75	0.16	0.00	8.37	2.00	0.00	8.72	0.17	0.00
8.53	2.00	0.00	8.70	0.16	0.00	8.69	2.00	0.00	8.68	0.16	0.00
8.86	2.00	0.00	8.65	0.17	0.00	9.02	2.00	0.00	8.63	0.16	0.00
9.19	2.00	0.00	8.60	0.17	0.00	9.35	2.00	0.00	8.58	0.16	0.00
9.51	2.00	0.00	8.55	0.16	0.00	9.68	2.00	0.00	8.52	0.17	0.00
9.84	2.00	0.00	8.50	0.16	0.00	10.01	2.00	0.00	8.47	0.17	0.00
10.17	2.00	0.00	8.45	0.16	0.00	10.34	2.00	0.00	8.42	0.17	0.00
10.50	2.00	0.00	8.40	0.16	0.00	10.66	2.00	0.00	8.38	0.16	0.00
10.83	2.00	0.00	8.35	0.17	0.00	10.99	2.00	0.00	8.33	0.16	0.00
11.16	2.00	0.00	8.30	0.17	0.00	11.32	2.00	0.00	8.27	0.16	0.00
11.48	2.00	0.00	8.25	0.16	0.00	11.65	2.00	0.00	8.22	0.17	0.00
11.81	2.00	0.00	8.20	0.16	0.00	11.98	2.00	0.00	8.17	0.17	0.00
12.14	2.00	0.00	8.15	0.16	0.00	12.30	2.00	0.00	8.13	0.16	0.00
12.47	2.00	0.00	8.10	0.17	0.00	12.63	2.00	0.00	8.08	0.16	0.00
12.80	2.00	0.00	8.05	0.17	0.00	12.96	2.00	0.00	8.02	0.16	0.00
13.12	2.00	0.00	8.00	0.16	0.00	13.29	2.00	0.00	7.97	0.17	0.00
13.45	2.00	0.00	7.95	0.16	0.00	13.62	2.00	0.00	7.92	0.17	0.00
13.78	2.00	0.00	7.90	0.16	0.00	13.94	0.54	0.46	7.88	0.16	0.18
14.11	2.00	0.00	7.85	0.17	0.00	14.27	2.00	0.00	7.83	0.16	0.00
14.44	2.00	0.00	7.80	0.17	0.00	14.60	2.00	0.00	7.77	0.16	0.00
14.76	2.00	0.00	7.75	0.16	0.00	14.93	2.00	0.00	7.72	0.17	0.00
15.09	2.00	0.00	7.70	0.16	0.00	15.26	2.00	0.00	7.67	0.17	0.00
15.42	2.00	0.00	7.65	0.16	0.00	15.58	2.00	0.00	7.63	0.16	0.00
15.75	2.00	0.00	7.60	0.17	0.00	15.91	2.00	0.00	7.58	0.16	0.00

:: Liquefaction Potential Index calculation data :: (continued)											
Depth (ft)	FS	F _L	w _z	d _z	LPI	Depth (ft)	FS	F _L	w _z	d _z	LPI
16.08	2.00	0.00	7.55	0.17	0.00	16.24	2.00	0.00	7.53	0.16	0.00
16.40	2.00	0.00	7.50	0.16	0.00	16.57	2.00	0.00	7.47	0.17	0.00
16.73	2.00	0.00	7.45	0.16	0.00	16.90	2.00	0.00	7.42	0.17	0.00
17.06	2.00	0.00	7.40	0.16	0.00	17.23	2.00	0.00	7.37	0.17	0.00
17.39	2.00	0.00	7.35	0.16	0.00	17.55	2.00	0.00	7.33	0.16	0.00
17.72	2.00	0.00	7.30	0.17	0.00	17.88	2.00	0.00	7.28	0.16	0.00
18.05	2.00	0.00	7.25	0.17	0.00	18.21	2.00	0.00	7.22	0.16	0.00
18.37	2.00	0.00	7.20	0.16	0.00	18.54	2.00	0.00	7.17	0.17	0.00
18.70	2.00	0.00	7.15	0.16	0.00	18.87	0.29	0.71	7.12	0.17	0.26
19.03	0.22	0.78	7.10	0.16	0.27	19.19	0.20	0.80	7.08	0.16	0.28
19.36	0.18	0.82	7.05	0.17	0.30	19.52	0.27	0.73	7.03	0.16	0.25
19.69	0.50	0.50	7.00	0.17	0.18	19.85	2.00	0.00	6.97	0.16	0.00
20.01	2.00	0.00	6.95	0.16	0.00	20.18	2.00	0.00	6.92	0.17	0.00
20.34	2.00	0.00	6.90	0.16	0.00	20.51	2.00	0.00	6.87	0.17	0.00
20.67	2.00	0.00	6.85	0.16	0.00	20.83	2.00	0.00	6.83	0.16	0.00
21.00	0.34	0.66	6.80	0.17	0.23	21.16	0.28	0.72	6.78	0.16	0.24
21.33	0.40	0.60	6.75	0.17	0.21	21.49	2.00	0.00	6.72	0.16	0.00
21.65	2.00	0.00	6.70	0.16	0.00	21.82	2.00	0.00	6.67	0.17	0.00
21.98	2.00	0.00	6.65	0.16	0.00	22.15	2.00	0.00	6.62	0.17	0.00
22.31	2.00	0.00	6.60	0.16	0.00	22.47	2.00	0.00	6.58	0.16	0.00
22.64	2.00	0.00	6.55	0.17	0.00	22.80	0.49	0.51	6.53	0.16	0.16
22.97	0.34	0.66	6.50	0.17	0.22	23.13	0.21	0.79	6.47	0.16	0.25
23.30	0.16	0.84	6.45	0.17	0.28	23.46	0.15	0.85	6.42	0.16	0.27
23.62	0.15	0.85	6.40	0.16	0.26	23.79	0.15	0.85	6.37	0.17	0.28
23.95	0.16	0.84	6.35	0.16	0.26	24.12	0.18	0.82	6.32	0.17	0.27
24.28	0.20	0.80	6.30	0.16	0.25	24.44	0.22	0.78	6.28	0.16	0.24
24.61	0.24	0.76	6.25	0.17	0.24	24.77	0.26	0.74	6.23	0.16	0.22
24.94	0.29	0.71	6.20	0.17	0.23	25.10	0.36	0.64	6.17	0.16	0.19
25.26	2.00	0.00	6.15	0.16	0.00	25.43	2.00	0.00	6.12	0.17	0.00
25.59	2.00	0.00	6.10	0.16	0.00	25.76	2.00	0.00	6.07	0.17	0.00
25.92	2.00	0.00	6.05	0.16	0.00	26.08	2.00	0.00	6.03	0.16	0.00
26.25	2.00	0.00	6.00	0.17	0.00	26.41	2.00	0.00	5.98	0.16	0.00
26.58	2.00	0.00	5.95	0.17	0.00	26.74	2.00	0.00	5.92	0.16	0.00
26.90	2.00	0.00	5.90	0.16	0.00	27.07	2.00	0.00	5.87	0.17	0.00
27.23	2.00	0.00	5.85	0.16	0.00	27.40	2.00	0.00	5.82	0.17	0.00
27.56	2.00	0.00	5.80	0.16	0.00	27.72	0.44	0.56	5.78	0.16	0.16
27.89	0.43	0.57	5.75	0.17	0.17	28.05	2.00	0.00	5.73	0.16	0.00
28.22	2.00	0.00	5.70	0.17	0.00	28.38	2.00	0.00	5.67	0.16	0.00
28.54	2.00	0.00	5.65	0.16	0.00	28.71	2.00	0.00	5.62	0.17	0.00
28.87	2.00	0.00	5.60	0.16	0.00	29.04	2.00	0.00	5.57	0.17	0.00
29.20	2.00	0.00	5.55	0.16	0.00	29.36	2.00	0.00	5.53	0.16	0.00
29.53	2.00	0.00	5.50	0.17	0.00	29.69	2.00	0.00	5.48	0.16	0.00
29.86	2.00	0.00	5.45	0.17	0.00	30.02	2.00	0.00	5.42	0.16	0.00
30.19	2.00	0.00	5.40	0.17	0.00	30.35	2.00	0.00	5.37	0.16	0.00
30.51	2.00	0.00	5.35	0.16	0.00	30.68	2.00	0.00	5.32	0.17	0.00
30.84	2.00	0.00	5.30	0.16	0.00	31.01	2.00	0.00	5.27	0.17	0.00
31.17	2.00	0.00	5.25	0.16	0.00	31.33	0.71	0.29	5.23	0.16	0.08
31.50	0.61	0.39	5.20	0.17	0.10	31.66	0.52	0.48	5.18	0.16	0.12

:: Liquefaction Potential Index calculation data :: (continued)											
Depth (ft)	FS	F _L	w _z	d _z	LPI	Depth (ft)	FS	F _L	w _z	d _z	LPI
31.83	0.52	0.48	5.15	0.17	0.13	31.99	0.53	0.47	5.12	0.16	0.12
32.15	0.59	0.41	5.10	0.16	0.10	32.32	2.00	0.00	5.07	0.17	0.00
32.48	2.00	0.00	5.05	0.16	0.00	32.65	2.00	0.00	5.02	0.17	0.00
32.81	2.00	0.00	5.00	0.16	0.00	32.97	2.00	0.00	4.98	0.16	0.00
33.14	2.00	0.00	4.95	0.17	0.00	33.30	2.00	0.00	4.93	0.16	0.00
33.47	2.00	0.00	4.90	0.17	0.00	33.63	2.00	0.00	4.87	0.16	0.00
33.79	2.00	0.00	4.85	0.16	0.00	33.96	0.49	0.51	4.82	0.17	0.13
34.12	0.41	0.59	4.80	0.16	0.14	34.29	0.30	0.70	4.77	0.17	0.17
34.45	0.21	0.79	4.75	0.16	0.18	34.61	0.23	0.77	4.73	0.16	0.18
34.78	0.31	0.69	4.70	0.17	0.17	34.94	2.00	0.00	4.68	0.16	0.00
35.11	2.00	0.00	4.65	0.17	0.00	35.27	2.00	0.00	4.62	0.16	0.00
35.43	2.00	0.00	4.60	0.16	0.00	35.60	2.00	0.00	4.57	0.17	0.00
35.76	2.00	0.00	4.55	0.16	0.00	35.93	2.00	0.00	4.52	0.17	0.00
36.09	2.00	0.00	4.50	0.16	0.00	36.26	2.00	0.00	4.47	0.17	0.00
36.42	2.00	0.00	4.45	0.16	0.00	36.58	2.00	0.00	4.43	0.16	0.00
36.75	2.00	0.00	4.40	0.17	0.00	36.91	2.00	0.00	4.37	0.16	0.00
37.08	2.00	0.00	4.35	0.17	0.00	37.24	2.00	0.00	4.32	0.16	0.00
37.40	2.00	0.00	4.30	0.16	0.00	37.57	2.00	0.00	4.27	0.17	0.00
37.73	2.00	0.00	4.25	0.16	0.00	37.90	2.00	0.00	4.22	0.17	0.00
38.06	2.00	0.00	4.20	0.16	0.00	38.22	2.00	0.00	4.18	0.16	0.00
38.39	2.00	0.00	4.15	0.17	0.00	38.55	2.00	0.00	4.12	0.16	0.00
38.72	2.00	0.00	4.10	0.17	0.00	38.88	2.00	0.00	4.07	0.16	0.00
39.04	2.00	0.00	4.05	0.16	0.00	39.21	2.00	0.00	4.02	0.17	0.00
39.37	2.00	0.00	4.00	0.16	0.00	39.54	2.00	0.00	3.97	0.17	0.00
39.70	2.00	0.00	3.95	0.16	0.00	39.86	2.00	0.00	3.93	0.16	0.00
40.03	2.00	0.00	3.90	0.17	0.00	40.19	2.00	0.00	3.88	0.16	0.00
40.36	2.00	0.00	3.85	0.17	0.00	40.52	2.00	0.00	3.82	0.16	0.00
40.68	2.00	0.00	3.80	0.16	0.00	40.85	2.00	0.00	3.77	0.17	0.00
41.01	2.00	0.00	3.75	0.16	0.00	41.18	2.00	0.00	3.72	0.17	0.00
41.34	2.00	0.00	3.70	0.16	0.00	41.50	2.00	0.00	3.68	0.16	0.00
41.67	2.00	0.00	3.65	0.17	0.00	41.83	2.00	0.00	3.63	0.16	0.00
42.00	2.00	0.00	3.60	0.17	0.00	42.16	0.50	0.50	3.57	0.16	0.09
42.32	0.48	0.52	3.55	0.16	0.09	42.49	0.47	0.53	3.52	0.17	0.10
42.65	0.48	0.52	3.50	0.16	0.09	42.82	0.51	0.49	3.47	0.17	0.09
42.98	0.54	0.46	3.45	0.16	0.08	43.15	0.56	0.44	3.42	0.17	0.08
43.31	0.55	0.45	3.40	0.16	0.07	43.47	0.54	0.46	3.38	0.16	0.08
43.64	0.52	0.48	3.35	0.17	0.08	43.80	0.50	0.50	3.32	0.16	0.08
43.97	0.50	0.50	3.30	0.17	0.09	44.13	0.50	0.50	3.27	0.16	0.08
44.29	0.52	0.48	3.25	0.16	0.08	44.46	0.54	0.46	3.22	0.17	0.08
44.62	0.55	0.45	3.20	0.16	0.07	44.79	0.53	0.47	3.17	0.17	0.08
44.95	0.50	0.50	3.15	0.16	0.08	45.11	2.00	0.00	3.13	0.16	0.00
45.28	2.00	0.00	3.10	0.17	0.00	45.44	2.00	0.00	3.07	0.16	0.00
45.61	2.00	0.00	3.05	0.17	0.00	45.77	2.00	0.00	3.02	0.16	0.00
45.93	2.00	0.00	3.00	0.16	0.00	46.10	2.00	0.00	2.97	0.17	0.00
46.26	2.00	0.00	2.95	0.16	0.00	46.43	2.00	0.00	2.92	0.17	0.00
46.59	2.00	0.00	2.90	0.16	0.00	46.75	2.00	0.00	2.88	0.16	0.00
46.92	2.00	0.00	2.85	0.17	0.00	47.08	2.00	0.00	2.83	0.16	0.00
47.25	2.00	0.00	2.80	0.17	0.00	47.41	2.00	0.00	2.77	0.16	0.00

:: Liquefaction Potential Index calculation data :: (continued)

Depth (ft)	FS	F_L	w_z	d_z	LPI	Depth (ft)	FS	F_L	w_z	d_z	LPI
47.57	2.00	0.00	2.75	0.16	0.00	47.74	2.00	0.00	2.72	0.17	0.00
47.90	2.00	0.00	2.70	0.16	0.00	48.07	2.00	0.00	2.67	0.17	0.00
48.23	2.00	0.00	2.65	0.16	0.00	48.39	2.00	0.00	2.63	0.16	0.00
48.56	2.00	0.00	2.60	0.17	0.00	48.72	2.00	0.00	2.58	0.16	0.00
48.89	2.00	0.00	2.55	0.17	0.00	49.05	2.00	0.00	2.52	0.16	0.00
49.22	0.56	0.44	2.50	0.17	0.06	49.38	0.46	0.54	2.47	0.16	0.07
49.54	0.35	0.65	2.45	0.16	0.08	49.71	0.31	0.69	2.42	0.17	0.09
49.87	0.33	0.67	2.40	0.16	0.08						

Overall liquefaction potential: 11.94

LPI = 0.00 - Liquefaction risk very low

LPI between 0.00 and 5.00 - Liquefaction risk low

LPI between 5.00 and 15.00 - Liquefaction risk high

LPI > 15.00 - Liquefaction risk very high

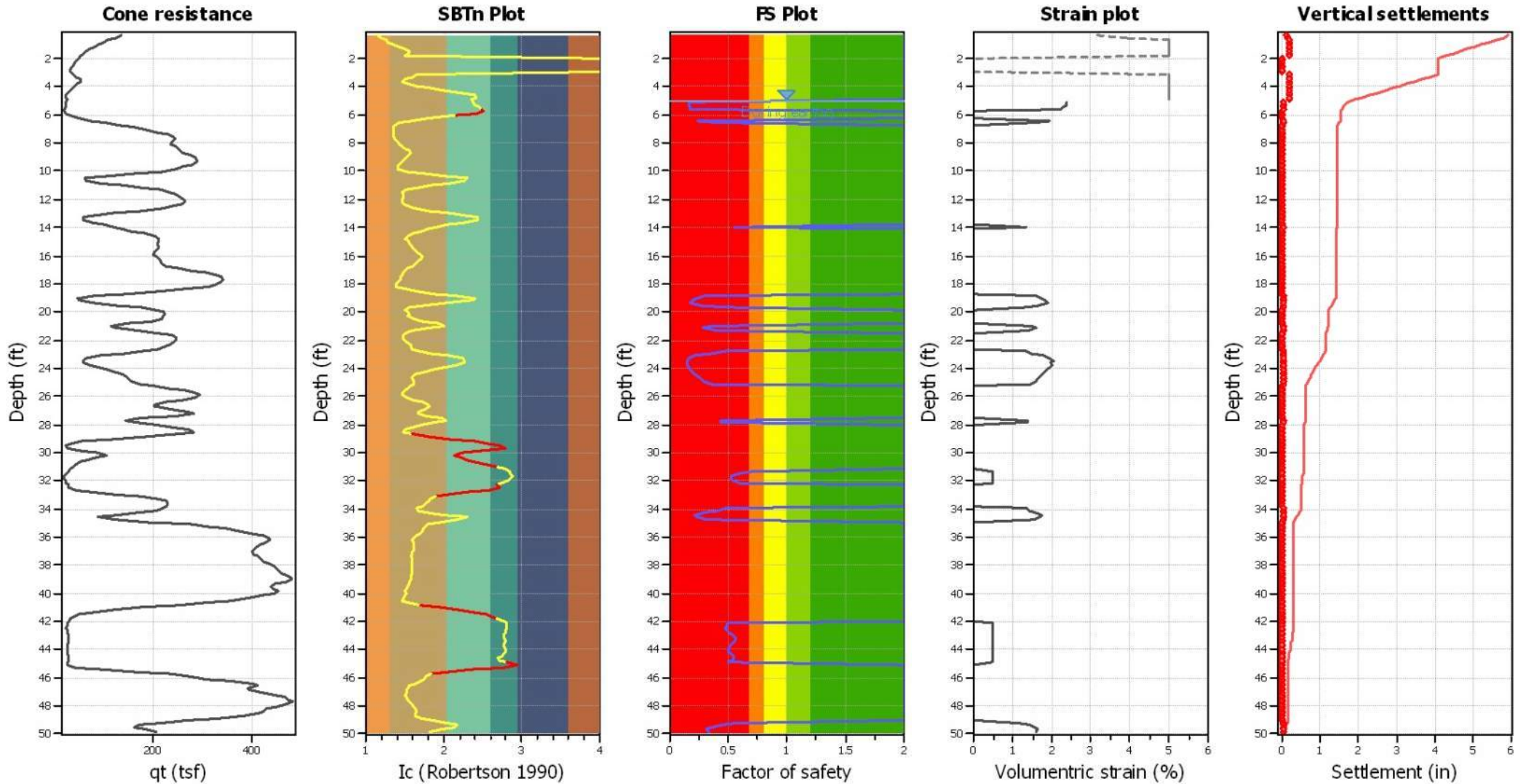
Abbreviations

FS: Calculated factor of safety for test point

 F_L : 1 - FS w_z : Function value of the extend of soil liquefaction according to depth d_z : Layer thickness (ft)

LPI: Liquefaction potential index value for test point

Estimation of post-earthquake settlements



Abbreviations

- qt: Total cone resistance (cone resistance q_c corrected for pore water effects)
- I_c : Soil Behaviour Type Index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post-liquefaction volumetric strain

:: Post-earthquake settlement of dry sands ::													
Depth (ft)	Ic	Kc	Qc1n	Qc1n,cs	N1,60 (blows)	Vs (ft/s)	Gmax (tsf)	CSR	Shear, γ (%)	Svol,15 (%)	Nc	ev (%)	Settle. (in)
0.33	1.16	1.00	256.22	256.22	40	755.0	130	1.01	6.288	2.72	21.37	3.19	0.122
0.49	1.21	1.00	233.83	233.83	37	745.6	155	1.01	7.098	3.36	21.37	3.94	0.151
0.66	1.26	1.00	205.02	205.02	33	719.9	165	1.01	14.191	7.73	21.37	5.00	0.204
0.82	1.28	1.00	185.22	185.22	30	696.5	169	1.01	29.319	17.86	21.37	5.00	0.192
0.98	1.34	1.00	169.07	169.07	28	687.4	179	1.01	36.461	24.32	21.37	5.00	0.192
1.15	1.42	1.00	153.05	153.05	26	691.7	199	1.00	26.951	19.60	21.37	5.00	0.204
1.31	1.49	1.00	136.21	136.21	24	681.1	205	1.00	35.873	29.24	21.37	5.00	0.192
1.48	1.56	1.00	121.20	121.20	22	670.8	210	1.00	47.911	43.75	21.37	5.00	0.204
1.64	1.54	1.00	109.65	109.65	19	631.7	190	1.00	244.177	253.02	21.37	5.00	0.192
1.80	1.50	1.00	100.94	100.94	18	589.4	164	1.00	2692.800	3134.99	21.37	5.00	0.192
1.97	4.06	26.61	93.18	2479.06	0	0.0	0	1.00	0.000	0.00	0.00	0.00	0.000
2.13	4.06	26.61	85.54	2275.90	0	0.0	0	1.00	0.000	0.00	0.00	0.00	0.000
2.30	4.06	26.61	77.46	2060.99	0	0.0	0	1.00	0.000	0.00	0.00	0.00	0.000
2.46	4.06	26.61	70.33	1871.24	0	0.0	0	1.00	0.000	0.00	0.00	0.00	0.000
2.62	4.06	26.61	64.77	1723.37	0	0.0	0	1.00	0.000	0.00	0.00	0.00	0.000
2.79	4.06	26.61	61.48	1635.83	0	0.0	0	1.00	0.000	0.00	0.00	0.00	0.000
2.95	4.06	26.61	61.16	1627.10	0	0.0	0	1.00	0.000	0.00	0.00	0.00	0.000
3.12	1.64	1.00	68.70	68.70	13	532.5	159	1.00	103602.17 2	180810. 93	21.37	5.00	0.204
3.28	1.59	1.00	84.56	84.56	15	572.0	200	1.00	4239.457	5886.08	21.37	5.00	0.192
3.45	1.51	1.00	99.86	99.86	17	588.3	217	1.00	1769.845	2082.83	21.37	5.00	0.204
3.61	1.47	1.00	99.78	99.78	17	575.5	202	1.00	6507.348	7766.96	21.37	5.00	0.192
3.77	1.52	1.00	89.43	89.43	16	562.0	196	1.00	13208.259	17641.7 0	21.37	5.00	0.192
3.94	1.64	1.00	76.81	76.81	14	563.1	211	1.00	5840.067	8914.76	21.37	5.00	0.204
4.10	1.81	1.00	69.17	69.17	13	593.0	250	1.00	746.025	1205.59	21.37	5.00	0.192
4.27	2.00	1.30	57.44	74.76	16	610.8	278	1.00	268.145	362.16	21.37	5.00	0.204
4.43	2.27	1.86	47.09	87.49	20	655.9	339	1.00	39.499	38.74	21.37	5.00	0.192
4.59	2.40	2.29	42.73	98.03	24	676.3	373	1.00	19.279	15.44	21.37	5.00	0.192
4.76	2.41	2.35	44.48	104.41	26	695.7	407	1.00	10.656	7.86	21.37	5.00	0.204
4.92	2.35	2.13	45.90	97.58	23	681.7	395	1.00	16.044	13.23	21.37	5.00	0.192

Total estimated settlement: 4.21

:: Post-earthquake settlement due to soil liquefaction ::													
Depth (ft)	Q _{tn,cs}	FS	ev (%)	DF	Settlement (in)	Depth (ft)	Q _{tn,cs}	FS	ev (%)	DF	Settlement (in)		
5.09	97.81	0.17	2.38	1.00	0.05	5.25	98.05	0.16	2.37	1.00	0.05		
5.41	101.91	0.17	2.30	1.00	0.04	5.58	106.05	0.18	2.23	1.00	0.05		
5.74	116.02	2.00	0.00	1.00	0.00	5.91	101.53	2.00	0.00	1.00	0.00		
6.07	92.86	2.00	0.00	1.00	0.00	6.23	103.66	2.00	0.00	1.00	0.00		
6.40	126.12	0.23	1.93	1.00	0.04	6.56	162.05	0.41	1.57	1.00	0.03		
6.73	201.72	2.00	0.00	1.00	0.00	6.89	239.81	2.00	0.00	1.00	0.00		
7.05	276.19	2.00	0.00	1.00	0.00	7.22	309.75	2.00	0.00	1.00	0.00		
7.38	340.85	2.00	0.00	1.00	0.00	7.55	359.15	2.00	0.00	1.00	0.00		
7.71	363.14	2.00	0.00	1.00	0.00	7.87	354.79	2.00	0.00	1.00	0.00		
8.04	354.26	2.00	0.00	1.00	0.00	8.20	366.90	2.00	0.00	1.00	0.00		
8.37	382.06	2.00	0.00	1.00	0.00	8.53	391.68	2.00	0.00	1.00	0.00		
8.69	401.97	2.00	0.00	1.00	0.00	8.86	415.85	2.00	0.00	1.00	0.00		
9.02	425.59	2.00	0.00	1.00	0.00	9.19	425.84	2.00	0.00	1.00	0.00		

:: Post-earthquake settlement due to soil liquefaction :: (continued)											
Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)
9.35	418.14	2.00	0.00	1.00	0.00	9.51	395.60	2.00	0.00	1.00	0.00
9.68	367.26	2.00	0.00	1.00	0.00	9.84	345.36	2.00	0.00	1.00	0.00
10.01	315.74	2.00	0.00	1.00	0.00	10.17	273.17	2.00	0.00	1.00	0.00
10.34	235.57	2.00	0.00	1.00	0.00	10.50	224.59	2.00	0.00	1.00	0.00
10.66	216.86	2.00	0.00	1.00	0.00	10.83	217.17	2.00	0.00	1.00	0.00
10.99	243.34	2.00	0.00	1.00	0.00	11.16	261.72	2.00	0.00	1.00	0.00
11.32	295.71	2.00	0.00	1.00	0.00	11.48	316.13	2.00	0.00	1.00	0.00
11.65	330.51	2.00	0.00	1.00	0.00	11.81	340.89	2.00	0.00	1.00	0.00
11.98	349.52	2.00	0.00	1.00	0.00	12.14	350.84	2.00	0.00	1.00	0.00
12.30	343.74	2.00	0.00	1.00	0.00	12.47	327.89	2.00	0.00	1.00	0.00
12.63	302.18	2.00	0.00	1.00	0.00	12.80	281.12	2.00	0.00	1.00	0.00
12.96	251.29	2.00	0.00	1.00	0.00	13.12	236.03	2.00	0.00	1.00	0.00
13.29	235.33	2.00	0.00	1.00	0.00	13.45	232.86	2.00	0.00	1.00	0.00
13.62	216.15	2.00	0.00	1.00	0.00	13.78	201.86	2.00	0.00	1.00	0.00
13.94	198.52	0.54	1.33	1.00	0.03	14.11	202.29	2.00	0.00	1.00	0.00
14.27	219.20	2.00	0.00	1.00	0.00	14.44	232.99	2.00	0.00	1.00	0.00
14.60	253.97	2.00	0.00	1.00	0.00	14.76	262.78	2.00	0.00	1.00	0.00
14.93	264.57	2.00	0.00	1.00	0.00	15.09	263.74	2.00	0.00	1.00	0.00
15.26	262.67	2.00	0.00	1.00	0.00	15.42	264.06	2.00	0.00	1.00	0.00
15.58	259.46	2.00	0.00	1.00	0.00	15.75	254.42	2.00	0.00	1.00	0.00
15.91	262.71	2.00	0.00	1.00	0.00	16.08	272.45	2.00	0.00	1.00	0.00
16.24	274.91	2.00	0.00	1.00	0.00	16.40	269.65	2.00	0.00	1.00	0.00
16.57	265.24	2.00	0.00	1.00	0.00	16.73	274.88	2.00	0.00	1.00	0.00
16.90	297.92	2.00	0.00	1.00	0.00	17.06	327.76	2.00	0.00	1.00	0.00
17.23	359.18	2.00	0.00	1.00	0.00	17.39	382.24	2.00	0.00	1.00	0.00
17.55	391.91	2.00	0.00	1.00	0.00	17.72	391.82	2.00	0.00	1.00	0.00
17.88	383.44	2.00	0.00	1.00	0.00	18.05	372.99	2.00	0.00	1.00	0.00
18.21	350.97	2.00	0.00	1.00	0.00	18.37	313.34	2.00	0.00	1.00	0.00
18.54	251.65	2.00	0.00	1.00	0.00	18.70	201.00	2.00	0.00	1.00	0.00
18.87	159.81	0.29	1.59	1.00	0.03	19.03	142.44	0.22	1.75	1.00	0.03
19.19	134.52	0.20	1.83	1.00	0.04	19.36	128.39	0.18	1.90	1.00	0.04
19.52	155.74	0.27	1.62	1.00	0.03	19.69	196.02	0.50	1.35	1.00	0.03
19.85	228.42	2.00	0.00	1.00	0.00	20.01	244.14	2.00	0.00	1.00	0.00
20.18	246.59	2.00	0.00	1.00	0.00	20.34	245.51	2.00	0.00	1.00	0.00
20.51	241.47	2.00	0.00	1.00	0.00	20.67	231.39	2.00	0.00	1.00	0.00
20.83	207.86	2.00	0.00	1.00	0.00	21.00	171.02	0.34	1.50	1.00	0.03
21.16	157.64	0.28	1.61	1.00	0.03	21.33	181.53	0.40	1.43	1.00	0.03
21.49	228.84	2.00	0.00	1.00	0.00	21.65	253.64	2.00	0.00	1.00	0.00
21.82	262.93	2.00	0.00	1.00	0.00	21.98	263.36	2.00	0.00	1.00	0.00
22.15	257.86	2.00	0.00	1.00	0.00	22.31	248.61	2.00	0.00	1.00	0.00
22.47	237.68	2.00	0.00	1.00	0.00	22.64	222.14	2.00	0.00	1.00	0.00
22.80	195.83	0.49	1.35	1.00	0.03	22.97	171.12	0.34	1.50	1.00	0.03
23.13	139.65	0.21	1.78	1.00	0.03	23.30	124.96	0.16	1.95	1.00	0.04
23.46	118.49	0.15	2.03	1.00	0.04	23.62	121.38	0.15	1.99	1.00	0.04
23.79	120.95	0.15	2.00	1.00	0.04	23.95	122.47	0.16	1.98	1.00	0.04
24.12	130.44	0.18	1.88	1.00	0.04	24.28	137.51	0.20	1.80	1.00	0.03
24.44	141.90	0.22	1.75	1.00	0.03	24.61	149.67	0.24	1.68	1.00	0.03
24.77	154.41	0.26	1.64	1.00	0.03	24.94	159.92	0.29	1.59	1.00	0.03

:: Post-earthquake settlement due to soil liquefaction :: (continued)											
Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)
25.10	175.96	0.36	1.47	1.00	0.03	25.26	202.36	2.00	0.00	1.00	0.00
25.43	235.60	2.00	0.00	1.00	0.00	25.59	264.93	2.00	0.00	1.00	0.00
25.76	286.26	2.00	0.00	1.00	0.00	25.92	293.76	2.00	0.00	1.00	0.00
26.08	283.75	2.00	0.00	1.00	0.00	26.25	258.89	2.00	0.00	1.00	0.00
26.41	239.93	2.00	0.00	1.00	0.00	26.58	224.63	2.00	0.00	1.00	0.00
26.74	227.32	2.00	0.00	1.00	0.00	26.90	247.94	2.00	0.00	1.00	0.00
27.07	272.56	2.00	0.00	1.00	0.00	27.23	284.43	2.00	0.00	1.00	0.00
27.40	260.87	2.00	0.00	1.00	0.00	27.56	218.01	2.00	0.00	1.00	0.00
27.72	188.47	0.44	1.39	1.00	0.03	27.89	188.02	0.43	1.39	1.00	0.03
28.05	210.86	2.00	0.00	1.00	0.00	28.22	237.93	2.00	0.00	1.00	0.00
28.38	260.26	2.00	0.00	1.00	0.00	28.54	270.39	2.00	0.00	1.00	0.00
28.71	242.60	2.00	0.00	1.00	0.00	28.87	197.80	2.00	0.00	1.00	0.00
29.04	150.53	2.00	0.00	1.00	0.00	29.20	116.83	2.00	0.00	1.00	0.00
29.36	134.64	2.00	0.00	1.00	0.00	29.53	85.94	2.00	0.00	1.00	0.00
29.69	104.26	2.00	0.00	1.00	0.00	29.86	124.47	2.00	0.00	1.00	0.00
30.02	140.66	2.00	0.00	1.00	0.00	30.19	150.10	2.00	0.00	1.00	0.00
30.35	134.64	2.00	0.00	1.00	0.00	30.51	114.38	2.00	0.00	1.00	0.00
30.68	101.60	2.00	0.00	1.00	0.00	30.84	132.01	2.00	0.00	1.00	0.00
31.01	323.71	2.00	0.00	1.00	0.00	31.17	133.10	2.00	0.00	1.00	0.00
31.33	122.05	0.71	0.50	1.00	0.01	31.50	105.96	0.61	0.50	1.00	0.01
31.66	95.55	0.52	0.50	1.00	0.01	31.83	91.29	0.52	0.50	1.00	0.01
31.99	91.03	0.53	0.50	1.00	0.01	32.15	85.91	0.59	0.50	1.00	0.01
32.32	204.89	2.00	0.00	1.00	0.00	32.48	101.21	2.00	0.00	1.00	0.00
32.65	155.11	2.00	0.00	1.00	0.00	32.81	124.59	2.00	0.00	1.00	0.00
32.97	147.37	2.00	0.00	1.00	0.00	33.14	181.28	2.00	0.00	1.00	0.00
33.30	210.54	2.00	0.00	1.00	0.00	33.47	223.93	2.00	0.00	1.00	0.00
33.63	220.08	2.00	0.00	1.00	0.00	33.79	211.43	2.00	0.00	1.00	0.00
33.96	195.91	0.49	1.35	1.00	0.03	34.12	183.74	0.41	1.42	1.00	0.03
34.29	163.03	0.30	1.57	1.00	0.03	34.45	140.54	0.21	1.77	1.00	0.03
34.61	144.38	0.23	1.73	1.00	0.03	34.78	163.81	0.31	1.56	1.00	0.03
34.94	203.09	2.00	0.00	1.00	0.00	35.11	260.93	2.00	0.00	1.00	0.00
35.27	292.13	2.00	0.00	1.00	0.00	35.43	318.66	2.00	0.00	1.00	0.00
35.60	338.94	2.00	0.00	1.00	0.00	35.76	355.75	2.00	0.00	1.00	0.00
35.93	365.52	2.00	0.00	1.00	0.00	36.09	374.61	2.00	0.00	1.00	0.00
36.26	373.11	2.00	0.00	1.00	0.00	36.42	364.73	2.00	0.00	1.00	0.00
36.58	356.34	2.00	0.00	1.00	0.00	36.75	348.54	2.00	0.00	1.00	0.00
36.91	341.83	2.00	0.00	1.00	0.00	37.08	339.10	2.00	0.00	1.00	0.00
37.24	341.76	2.00	0.00	1.00	0.00	37.40	347.07	2.00	0.00	1.00	0.00
37.57	350.70	2.00	0.00	1.00	0.00	37.73	356.32	2.00	0.00	1.00	0.00
37.90	362.83	2.00	0.00	1.00	0.00	38.06	370.54	2.00	0.00	1.00	0.00
38.22	373.46	2.00	0.00	1.00	0.00	38.39	375.53	2.00	0.00	1.00	0.00
38.55	380.16	2.00	0.00	1.00	0.00	38.72	388.03	2.00	0.00	1.00	0.00
38.88	395.07	2.00	0.00	1.00	0.00	39.04	394.73	2.00	0.00	1.00	0.00
39.21	384.50	2.00	0.00	1.00	0.00	39.37	366.84	2.00	0.00	1.00	0.00
39.54	360.09	2.00	0.00	1.00	0.00	39.70	363.99	2.00	0.00	1.00	0.00
39.86	371.14	2.00	0.00	1.00	0.00	40.03	362.38	2.00	0.00	1.00	0.00
40.19	343.63	2.00	0.00	1.00	0.00	40.36	319.89	2.00	0.00	1.00	0.00
40.52	290.44	2.00	0.00	1.00	0.00	40.68	249.50	2.00	0.00	1.00	0.00

:: Post-earthquake settlement due to soil liquefaction :: (continued)											
Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)
40.85	204.00	2.00	0.00	1.00	0.00	41.01	168.96	2.00	0.00	1.00	0.00
41.18	141.59	2.00	0.00	1.00	0.00	41.34	121.33	2.00	0.00	1.00	0.00
41.50	126.13	2.00	0.00	1.00	0.00	41.67	148.80	2.00	0.00	1.00	0.00
41.83	180.20	2.00	0.00	1.00	0.00	42.00	77.09	2.00	0.00	1.00	0.00
42.16	75.51	0.50	0.50	1.00	0.01	42.32	73.69	0.48	0.50	1.00	0.01
42.49	71.76	0.47	0.50	1.00	0.01	42.65	71.62	0.48	0.50	1.00	0.01
42.82	73.25	0.51	0.50	1.00	0.01	42.98	76.59	0.54	0.50	1.00	0.01
43.15	78.12	0.56	0.50	1.00	0.01	43.31	79.76	0.55	0.50	1.00	0.01
43.47	78.05	0.54	0.50	1.00	0.01	43.64	74.53	0.52	0.50	1.00	0.01
43.80	70.87	0.50	0.50	1.00	0.01	43.97	70.85	0.50	0.50	1.00	0.01
44.13	72.61	0.50	0.50	1.00	0.01	44.29	74.19	0.52	0.50	1.00	0.01
44.46	72.15	0.54	0.50	1.00	0.01	44.62	68.23	0.55	0.50	1.00	0.01
44.79	66.30	0.53	0.50	1.00	0.01	44.95	73.98	0.50	0.50	1.00	0.01
45.11	94.54	2.00	0.00	1.00	0.00	45.28	116.66	2.00	0.00	1.00	0.00
45.44	132.59	2.00	0.00	1.00	0.00	45.61	159.59	2.00	0.00	1.00	0.00
45.77	194.12	2.00	0.00	1.00	0.00	45.93	220.43	2.00	0.00	1.00	0.00
46.10	244.29	2.00	0.00	1.00	0.00	46.26	276.80	2.00	0.00	1.00	0.00
46.43	302.33	2.00	0.00	1.00	0.00	46.59	311.50	2.00	0.00	1.00	0.00
46.75	296.55	2.00	0.00	1.00	0.00	46.92	297.86	2.00	0.00	1.00	0.00
47.08	318.27	2.00	0.00	1.00	0.00	47.25	340.89	2.00	0.00	1.00	0.00
47.41	351.94	2.00	0.00	1.00	0.00	47.57	355.07	2.00	0.00	1.00	0.00
47.74	360.33	2.00	0.00	1.00	0.00	47.90	346.80	2.00	0.00	1.00	0.00
48.07	328.49	2.00	0.00	1.00	0.00	48.23	313.22	2.00	0.00	1.00	0.00
48.39	309.60	2.00	0.00	1.00	0.00	48.56	302.66	2.00	0.00	1.00	0.00
48.72	277.72	2.00	0.00	1.00	0.00	48.89	244.72	2.00	0.00	1.00	0.00
49.05	217.55	2.00	0.00	1.00	0.00	49.22	195.64	0.56	1.15	1.00	0.02
49.38	181.47	0.46	1.43	1.00	0.03	49.54	162.62	0.35	1.57	1.00	0.03
49.71	155.01	0.31	1.63	1.00	0.03	49.87	159.35	0.33	1.59	1.00	0.03

Total estimated settlement: 1.71

Abbreviations

- $Q_{tn,cs}$: Equivalent clean sand normalized cone resistance
- FS: Factor of safety against liquefaction
- e_v (%): Post-liquefaction volumetric strain
- DF: e_v depth weighting factor
- Settlement: Calculated settlement

:: Strength loss calculation (Robertson (2009)) ::

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
0.33	135.57	256.22	1.00	256.22	1.16	N/A	N/A
0.49	123.74	233.83	1.00	233.83	1.21	N/A	N/A
0.66	108.50	205.02	1.00	205.02	1.26	N/A	N/A
0.82	98.03	185.22	1.00	185.22	1.28	N/A	N/A
0.98	89.50	169.07	1.00	169.07	1.34	N/A	N/A
1.15	81.03	153.05	1.00	153.05	1.42	N/A	N/A
1.31	72.13	136.21	1.00	136.21	1.49	N/A	N/A
1.48	64.20	121.20	1.00	121.20	1.56	N/A	N/A
1.64	58.10	109.65	1.00	109.65	1.54	N/A	N/A
1.80	53.50	100.94	1.00	100.94	1.50	N/A	N/A
1.97	49.40	93.18	26.61	2479.06	4.06	N/A	N/A
2.13	45.37	85.54	26.61	2275.90	4.06	N/A	N/A
2.30	41.10	77.46	26.61	2060.99	4.06	N/A	N/A
2.46	37.34	70.33	26.61	1871.24	4.06	N/A	N/A
2.62	34.40	64.77	26.61	1723.37	4.06	N/A	N/A
2.79	32.67	61.48	26.61	1635.83	4.06	N/A	N/A
2.95	32.50	61.16	26.61	1627.10	4.06	N/A	N/A
3.12	36.50	68.70	1.00	68.70	1.64	N/A	N/A
3.28	44.90	84.56	1.00	84.56	1.59	N/A	N/A
3.45	53.00	99.86	1.00	99.86	1.51	N/A	N/A
3.61	52.97	99.78	1.00	99.78	1.47	N/A	N/A
3.77	47.50	89.43	1.00	89.43	1.52	N/A	N/A
3.94	40.83	76.81	1.00	76.81	1.64	N/A	N/A
4.10	36.80	69.17	1.00	69.17	1.81	N/A	N/A
4.27	30.60	57.44	1.30	74.76	2.00	N/A	N/A
4.43	25.14	47.09	1.86	87.49	2.27	N/A	N/A
4.59	22.84	42.73	2.29	98.03	2.40	N/A	N/A
4.76	23.77	44.48	2.35	104.41	2.41	N/A	N/A
4.92	24.53	45.90	2.13	97.58	2.35	N/A	N/A
5.09	23.59	44.10	2.22	97.81	2.38	0.72	0.72
5.25	22.82	42.62	2.30	98.05	2.40	0.71	0.71
5.41	21.79	40.66	2.51	101.91	2.45	0.71	0.71
5.58	20.56	38.32	2.77	106.05	2.50	0.70	0.70
5.74	20.06	37.36	2.85	106.37	2.52	0.70	0.70
5.91	22.66	42.26	2.40	101.53	2.42	0.71	0.71
6.07	32.40	60.64	1.53	92.86	2.14	0.76	0.76
6.23	49.74	93.40	1.11	103.66	1.80	0.82	0.82
6.40	73.47	126.12	1.00	126.12	1.58	0.86	0.86
6.56	101.60	162.05	1.00	162.05	1.44	0.90	0.90
6.73	130.66	201.72	1.00	201.72	1.38	0.93	0.93
6.89	158.33	239.81	1.00	239.81	1.35	0.96	0.96
7.05	183.20	276.19	1.00	276.19	1.35	0.98	0.98
7.22	206.67	309.75	1.00	309.75	1.35	1.00	1.00
7.38	228.67	340.85	1.00	340.85	1.35	1.02	1.02
7.55	241.87	359.15	1.00	359.15	1.36	1.03	1.03
7.71	243.48	363.14	1.00	363.14	1.38	1.03	1.03
7.87	236.94	354.79	1.00	354.79	1.40	1.02	1.02
8.04	235.88	354.26	1.00	354.26	1.42	1.02	1.02

:: Strength loss calculation (Robertson (2009)) :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
8.20	242.08	366.90	1.00	366.90	1.46	1.03	1.03
8.37	248.81	382.06	1.00	382.06	1.51	1.04	1.04
8.53	251.81	391.68	1.00	391.68	1.55	1.04	1.04
8.69	258.50	401.97	1.00	401.97	1.57	1.04	1.04
8.86	271.36	415.85	1.00	415.85	1.55	1.05	1.05
9.02	283.19	425.59	1.00	425.59	1.52	1.05	1.05
9.19	288.75	425.84	1.00	425.84	1.49	1.05	1.05
9.35	287.35	418.14	1.00	418.14	1.47	1.05	1.05
9.51	277.55	395.60	1.00	395.60	1.43	1.04	1.04
9.68	261.02	367.26	1.00	367.26	1.41	1.03	1.03
9.84	246.82	345.36	1.00	345.36	1.41	1.02	1.02
10.01	216.09	315.74	1.00	315.74	1.54	1.00	1.00
10.17	164.82	256.64	1.06	273.17	1.74	0.97	0.97
10.34	101.32	174.00	1.35	235.57	2.04	0.91	0.91
10.50	61.70	114.78	1.96	224.59	2.30	0.85	0.85
10.66	64.68	117.78	1.84	216.86	2.26	0.85	0.85
10.83	93.42	157.36	1.38	217.17	2.06	0.89	0.89
10.99	138.66	215.34	1.13	243.34	1.83	0.94	0.94
11.16	179.78	261.21	1.00	261.72	1.65	0.97	0.97
11.32	212.75	295.71	1.00	295.71	1.53	0.99	0.99
11.48	232.58	316.13	1.00	316.13	1.47	1.00	1.00
11.65	243.88	330.51	1.00	330.51	1.48	1.01	1.01
11.81	253.11	340.89	1.00	340.89	1.48	1.02	1.02
11.98	261.41	349.52	1.00	349.52	1.47	1.02	1.02
12.14	263.97	350.84	1.00	350.84	1.46	1.02	1.02
12.30	258.91	343.74	1.00	343.74	1.48	1.02	1.02
12.47	244.80	327.89	1.00	327.89	1.52	1.01	1.01
12.63	219.57	302.84	1.00	302.18	1.64	1.00	1.00
12.80	173.43	250.24	1.12	281.12	1.82	0.97	0.97
12.96	122.50	186.25	1.35	251.29	2.04	0.92	0.92
13.12	77.87	125.40	1.88	236.03	2.28	0.86	0.86
13.29	58.51	97.03	2.43	235.33	2.43	0.82	0.82
13.45	58.19	95.76	2.43	232.86	2.43	0.82	0.82
13.62	77.37	120.69	1.79	216.15	2.25	0.85	0.85
13.78	98.77	145.87	1.38	201.86	2.06	0.88	0.88
13.94	119.39	168.07	1.18	198.52	1.89	0.90	0.90
14.11	133.38	182.56	1.11	202.29	1.80	0.92	0.92
14.27	156.65	208.95	1.05	219.20	1.72	0.94	0.94
14.44	180.24	232.99	1.00	232.99	1.61	0.95	0.95
14.60	200.81	253.97	1.00	253.97	1.53	0.97	0.97
14.76	209.81	262.78	1.00	262.78	1.51	0.97	0.97
14.93	210.34	264.57	1.00	264.57	1.55	0.97	0.97
15.09	209.57	263.74	1.00	263.74	1.57	0.97	0.97
15.26	209.00	262.67	1.00	262.67	1.58	0.97	0.97
15.42	210.37	264.06	1.00	264.06	1.59	0.97	0.97
15.58	206.87	259.46	1.00	259.46	1.61	0.97	0.97
15.75	201.03	253.29	1.00	254.42	1.65	0.97	0.97
15.91	199.30	252.74	1.04	262.71	1.70	0.97	0.97

:: Strength loss calculation (Robertson (2009)) :: (continued)							
Depth (ft)	q _t (tsf)	Q _{tn}	K _c	Q _{tn,cs}	I _c	S _{u(liq)/σ'_v}	S _{u(peak)/σ'_v}
16.08	204.33	258.91	1.05	272.45	1.72	0.97	0.97
16.24	210.83	264.77	1.04	274.91	1.70	0.97	0.97
16.40	213.07	264.78	1.02	269.65	1.67	0.97	0.97
16.57	216.03	265.24	1.00	265.24	1.63	0.97	0.97
16.73	226.60	274.88	1.00	274.88	1.59	0.98	0.98
16.90	248.93	297.92	1.00	297.92	1.54	0.99	0.99
17.06	276.60	327.76	1.00	327.76	1.51	1.01	1.01
17.23	305.37	359.18	1.00	359.18	1.49	1.03	1.03
17.39	327.61	382.24	1.00	382.24	1.47	1.04	1.04
17.55	338.18	391.91	1.00	391.91	1.45	1.04	1.04
17.72	339.98	391.82	1.00	391.82	1.44	1.04	1.04
17.88	335.51	383.44	1.00	383.44	1.41	1.04	1.04
18.05	328.54	372.99	1.00	372.99	1.39	1.03	1.03
18.21	310.14	350.97	1.00	350.97	1.40	1.02	1.02
18.37	273.60	313.34	1.00	313.34	1.49	1.00	1.00
18.54	213.40	249.88	1.01	251.65	1.66	0.96	0.96
18.70	143.36	172.69	1.16	201.00	1.87	0.91	0.91
18.87	83.22	103.57	1.54	159.81	2.15	0.83	0.83
19.03	47.96	61.19	2.33	142.44	2.40	0.76	0.76
19.19	48.50	61.25	2.20	134.52	2.37	0.76	0.76
19.36	79.29	95.54	1.34	128.39	2.03	0.82	0.82
19.52	128.27	147.89	1.05	155.74	1.72	0.88	0.88
19.69	174.50	196.02	1.00	196.02	1.55	0.93	0.93
19.85	204.93	228.42	1.00	228.42	1.51	0.95	0.95
20.01	219.00	244.14	1.00	244.14	1.53	0.96	0.96
20.18	221.39	246.59	1.00	246.59	1.55	0.96	0.96
20.34	221.29	245.51	1.00	245.51	1.55	0.96	0.96
20.51	216.66	241.47	1.00	241.47	1.61	0.96	0.96
20.67	193.02	217.72	1.06	231.39	1.74	0.94	0.94
20.83	149.15	171.25	1.21	207.86	1.93	0.91	0.91
21.00	114.32	131.54	1.30	171.02	2.00	0.87	0.87
21.16	123.76	139.14	1.13	157.64	1.83	0.87	0.87
21.33	166.36	181.53	1.00	181.53	1.59	0.91	0.91
21.49	212.19	228.84	1.00	228.84	1.50	0.95	0.95
21.65	236.15	253.64	1.00	253.64	1.49	0.97	0.97
21.82	245.45	262.93	1.00	262.93	1.49	0.97	0.97
21.98	246.45	263.36	1.00	263.36	1.49	0.97	0.97
22.15	241.32	257.86	1.00	257.86	1.52	0.97	0.97
22.31	232.35	248.61	1.00	248.61	1.57	0.96	0.96
22.47	222.78	237.68	1.00	237.68	1.57	0.96	0.96
22.64	208.51	222.14	1.00	222.14	1.60	0.95	0.95
22.80	180.94	193.22	1.01	195.83	1.66	0.92	0.92
22.97	139.37	150.40	1.14	171.12	1.84	0.89	0.89
23.13	94.70	103.17	1.35	139.65	2.04	0.83	0.83
23.30	63.68	69.84	1.79	124.96	2.25	0.78	0.78
23.46	58.35	63.72	1.86	118.49	2.27	0.77	0.77
23.62	59.63	64.89	1.87	121.38	2.27	0.77	0.77
23.79	71.93	77.48	1.56	120.95	2.15	0.79	0.79

:: Strength loss calculation (Robertson (2009)) :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
23.95	84.80	90.43	1.35	122.47	2.04	0.81	0.81
24.12	107.23	112.78	1.16	130.44	1.86	0.84	0.84
24.28	125.69	130.65	1.05	137.51	1.72	0.87	0.87
24.44	137.62	141.90	1.00	141.90	1.64	0.88	0.88
24.61	145.95	149.67	1.00	149.67	1.59	0.89	0.89
24.77	150.78	154.41	1.00	154.41	1.61	0.89	0.89
24.94	156.38	159.92	1.00	159.92	1.62	0.90	0.90
25.10	172.48	175.96	1.00	175.96	1.62	0.91	0.91
25.26	199.12	202.36	1.00	202.36	1.58	0.93	0.93
25.43	232.85	235.60	1.00	235.60	1.54	0.96	0.96
25.59	262.96	264.93	1.00	264.93	1.50	0.97	0.97
25.76	285.33	286.26	1.00	286.26	1.47	0.99	0.99
25.92	293.63	293.76	1.00	293.76	1.46	0.99	0.99
26.08	283.63	283.75	1.00	283.75	1.52	0.99	0.99
26.25	258.42	258.89	1.00	258.89	1.62	0.97	0.97
26.41	226.49	227.15	1.06	239.93	1.73	0.95	0.95
26.58	201.69	202.10	1.11	224.63	1.81	0.93	0.93
26.74	202.22	202.10	1.12	227.32	1.82	0.93	0.93
26.90	230.86	229.59	1.08	247.94	1.76	0.95	0.95
27.07	270.13	267.11	1.02	272.56	1.67	0.98	0.98
27.23	281.80	277.88	1.02	284.43	1.68	0.98	0.98
27.40	243.10	239.44	1.09	260.87	1.78	0.96	0.96
27.56	175.29	172.62	1.26	218.01	1.97	0.91	0.91
27.72	142.96	140.20	1.34	188.47	2.03	0.88	0.88
27.89	162.20	158.13	1.19	188.02	1.90	0.89	0.89
28.05	208.90	202.53	1.04	210.86	1.70	0.93	0.93
28.22	246.56	237.93	1.00	237.93	1.57	0.96	0.96
28.38	270.62	260.26	1.00	260.26	1.50	0.97	0.97
28.54	281.86	270.39	1.00	270.39	1.49	0.98	0.98
28.71	253.29	242.60	1.00	242.60	1.60	0.96	0.96
28.87	186.05	177.74	1.11	197.80	1.81	0.91	0.91
29.04	110.01	104.39	1.44	150.53	2.09	0.83	0.83
29.20	54.94	51.25	2.28	116.83	2.39	0.74	0.74
29.36	31.58	28.66	3.20	91.60	2.58	0.67	0.67
29.53	23.76	21.07	4.08	85.94	2.71	1.51	1.51
29.69	24.90	22.07	4.72	104.26	2.79	1.58	1.58
29.86	57.31	52.74	2.36	124.47	2.41	0.74	0.74
30.02	86.82	80.45	1.75	140.66	2.23	0.80	0.80
30.19	106.27	98.47	1.52	150.10	2.14	0.83	0.83
30.35	87.47	80.45	1.67	134.64	2.20	0.80	0.80
30.51	66.58	60.58	1.89	114.38	2.28	0.76	0.76
30.68	53.12	47.78	2.13	101.60	2.35	0.73	0.73
30.84	43.66	38.77	2.92	113.21	2.53	0.70	0.70
31.01	37.39	32.75	3.96	129.73	2.70	2.33	2.33
31.17	32.34	27.93	4.77	133.10	2.80	1.99	1.99
31.33	27.94	23.78	5.13	122.05	2.84	1.70	1.70
31.50	24.67	20.69	5.12	105.96	2.84	1.48	1.48
31.66	21.21	17.46	5.47	95.55	2.88	1.25	1.25

:: Strength loss calculation (Robertson (2009)) :: (continued)							
Depth (ft)	q _t (tsf)	Q _{tn}	K _c	Q _{tn,cs}	I _c	S _{u(liq)/σ'_v}	S _{u(peak)/σ'_v}
31.83	21.50	17.65	5.17	91.29	2.84	1.26	1.26
31.99	21.88	17.92	5.08	91.03	2.83	1.28	1.28
32.15	24.16	19.93	4.31	85.91	2.74	1.42	1.42
32.32	27.77	23.10	3.84	88.66	2.68	1.64	1.64
32.48	30.05	25.03	4.04	101.21	2.71	1.78	1.78
32.65	43.56	37.05	3.09	114.62	2.56	0.70	0.70
32.81	72.79	63.28	1.97	124.59	2.31	0.76	0.76
32.97	124.71	110.18	1.34	147.37	2.03	0.84	0.84
33.14	173.48	154.10	1.18	181.28	1.89	0.89	0.89
33.30	210.16	186.85	1.13	210.54	1.83	0.92	0.92
33.47	225.85	200.40	1.12	223.93	1.81	0.93	0.93
33.63	230.03	203.94	1.08	220.08	1.76	0.93	0.93
33.79	226.85	200.84	1.05	211.43	1.72	0.93	0.93
33.96	219.63	194.36	1.01	195.91	1.66	0.93	0.93
34.12	204.19	179.99	1.02	183.74	1.68	0.91	0.91
34.29	172.47	150.76	1.08	163.03	1.76	0.89	0.89
34.45	126.17	108.36	1.30	140.54	2.00	0.84	0.84
34.61	87.99	73.72	1.96	144.38	2.30	0.79	0.79
34.78	121.60	102.86	1.59	163.81	2.17	0.83	0.83
34.94	190.92	163.75	1.24	203.09	1.95	0.90	0.90
35.11	273.91	236.89	1.10	260.93	1.79	0.96	0.96
35.27	312.31	269.97	1.08	292.13	1.77	0.98	0.98
35.43	345.04	297.89	1.07	318.66	1.75	0.99	0.99
35.60	373.91	322.50	1.05	338.94	1.72	1.01	1.01
35.76	401.69	346.36	1.03	355.75	1.68	1.02	1.02
35.93	423.86	365.39	1.00	365.52	1.65	1.03	1.03
36.09	434.89	374.61	1.00	374.61	1.62	1.03	1.03
36.26	433.91	373.11	1.00	373.11	1.60	1.03	1.03
36.42	425.54	364.73	1.00	364.73	1.61	1.03	1.03
36.58	417.10	356.34	1.00	356.34	1.62	1.02	1.02
36.75	409.16	348.54	1.00	348.54	1.62	1.02	1.02
36.91	402.13	341.83	1.00	341.83	1.61	1.02	1.02
37.08	399.46	339.10	1.00	339.10	1.60	1.02	1.02
37.24	403.32	341.76	1.00	341.76	1.59	1.02	1.02
37.40	410.39	347.07	1.00	347.07	1.58	1.02	1.02
37.57	415.96	350.70	1.00	350.70	1.59	1.02	1.02
37.73	423.66	356.32	1.00	356.32	1.59	1.02	1.02
37.90	432.63	362.83	1.00	362.83	1.60	1.03	1.03
38.06	442.83	370.54	1.00	370.54	1.60	1.03	1.03
38.22	447.40	373.46	1.00	373.46	1.60	1.03	1.03
38.39	450.87	375.53	1.00	375.53	1.59	1.03	1.03
38.55	457.33	380.16	1.00	380.16	1.59	1.03	1.03
38.72	467.74	388.03	1.00	388.03	1.58	1.04	1.04
38.88	477.07	395.07	1.00	395.07	1.58	1.04	1.04
39.04	477.51	394.73	1.00	394.73	1.57	1.04	1.04
39.21	466.07	384.50	1.00	384.50	1.57	1.04	1.04
39.37	445.73	366.84	1.00	366.84	1.56	1.03	1.03
39.54	437.63	360.09	1.00	360.09	1.54	1.03	1.03

:: Strength loss calculation (Robertson (2009)) :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
39.70	442.56	363.99	1.00	363.99	1.52	1.03	1.03
39.86	451.63	371.14	1.00	371.14	1.51	1.03	1.03
40.03	442.29	362.38	1.00	362.38	1.52	1.03	1.03
40.19	419.98	343.63	1.00	343.63	1.51	1.02	1.02
40.36	390.70	319.89	1.00	319.89	1.48	1.01	1.01
40.52	355.55	290.44	1.00	290.44	1.47	0.99	0.99
40.68	308.43	249.50	1.00	249.50	1.53	0.96	0.96
40.85	248.67	196.59	1.04	204.00	1.70	0.93	0.93
41.01	182.39	139.72	1.21	168.96	1.92	0.88	0.88
41.18	120.38	88.68	1.60	141.59	2.17	0.81	0.81
41.34	74.75	52.75	2.30	121.33	2.40	0.74	0.74
41.50	49.40	33.53	3.00	100.67	2.54	0.68	0.68
41.67	37.80	24.93	3.42	85.30	2.62	1.73	1.73
41.83	31.66	20.36	3.84	78.10	2.68	1.43	1.43
42.00	27.42	17.15	4.49	77.09	2.77	1.21	1.21
42.16	25.53	15.71	4.81	75.51	2.80	1.12	1.12
42.32	24.65	15.04	4.90	73.69	2.81	1.07	1.07
42.49	24.27	14.74	4.87	71.76	2.81	1.05	1.05
42.65	24.77	15.05	4.76	71.62	2.80	1.07	1.07
42.82	25.96	15.84	4.62	73.25	2.78	1.12	1.12
42.98	27.45	16.83	4.55	76.59	2.77	1.19	1.19
43.15	28.30	17.36	4.50	78.12	2.77	1.23	1.23
43.31	28.29	17.26	4.62	79.76	2.78	1.22	1.22
43.47	27.71	16.81	4.64	78.05	2.78	1.19	1.19
43.64	26.93	16.25	4.59	74.53	2.78	1.15	1.15
43.80	26.10	15.65	4.53	70.87	2.77	1.11	1.11
43.97	25.74	15.34	4.62	70.85	2.78	1.09	1.09
44.13	26.04	15.47	4.69	72.61	2.79	1.10	1.10
44.29	27.10	16.15	4.59	74.19	2.78	1.15	1.15
44.46	27.91	16.71	4.32	72.15	2.74	1.18	1.18
44.62	28.19	16.94	4.03	68.23	2.70	0.33	1.19
44.79	27.52	16.44	4.03	66.30	2.71	0.26	1.15
44.95	26.34	15.39	4.81	73.98	2.80	1.10	1.10
45.11	26.61	15.46	6.12	94.54	2.94	1.10	1.10
45.28	43.94	26.93	4.33	116.66	2.74	1.90	1.90
45.44	92.46	61.90	2.14	132.59	2.36	0.76	0.76
45.61	168.93	120.11	1.33	159.59	2.02	0.85	0.85
45.77	233.80	171.22	1.13	194.12	1.84	0.91	0.91
45.93	275.56	203.88	1.08	220.43	1.76	0.93	0.93
46.10	307.76	227.83	1.07	244.29	1.75	0.95	0.95
46.26	355.88	264.77	1.05	276.80	1.71	0.97	0.97
46.43	402.28	302.33	1.00	302.33	1.64	1.00	1.00
46.59	410.89	311.50	1.00	311.50	1.57	1.00	1.00
46.75	390.92	296.55	1.00	296.55	1.55	0.99	0.99
46.92	392.33	297.86	1.00	297.86	1.53	0.99	0.99
47.08	419.57	318.27	1.00	318.27	1.53	1.00	1.00
47.25	449.16	340.89	1.00	340.89	1.51	1.02	1.02
47.41	465.53	351.94	1.00	351.94	1.53	1.02	1.02

:: Strength loss calculation (Robertson (2009)) :: (continued)

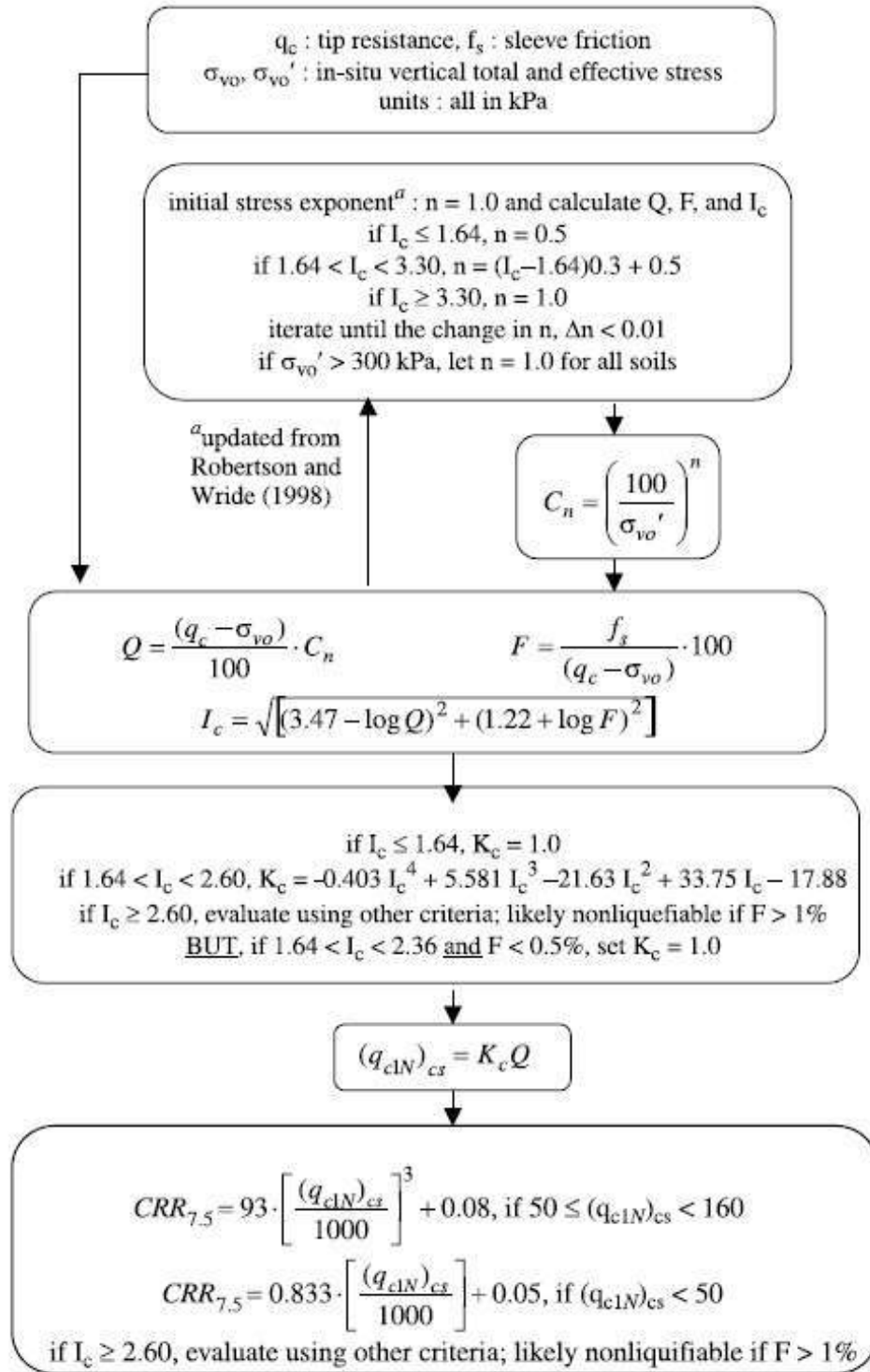
Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
47.57	472.27	355.07	1.00	355.07	1.55	1.02	1.02
47.74	481.40	360.33	1.00	360.33	1.56	1.03	1.03
47.90	466.97	346.80	1.00	346.80	1.60	1.02	1.02
48.07	445.41	328.49	1.00	328.49	1.62	1.01	1.01
48.23	428.68	314.41	1.00	313.22	1.64	1.00	1.00
48.39	423.94	310.08	1.00	309.60	1.64	1.00	1.00
48.56	414.07	302.66	1.00	302.66	1.63	1.00	1.00
48.72	382.90	278.78	1.00	277.72	1.64	0.98	0.98
48.89	325.19	232.57	1.05	244.72	1.72	0.95	0.95
49.05	270.95	188.22	1.16	217.55	1.86	0.92	0.92
49.22	213.65	142.76	1.37	195.64	2.05	0.88	0.88
49.38	173.15	112.39	1.61	181.47	2.18	0.84	0.84
49.54	162.50	105.73	1.54	162.62	2.14	0.84	0.84
49.71	180.30	120.55	1.29	155.01	1.99	0.85	0.85
49.87	205.43	141.48	1.13	159.35	1.83	0.88	0.88

Abbreviations

q_t :	Total cone resistance
K_c :	Cone resistance correction factor due to fines
$Q_{tn,cs}$:	Adjusted and corrected cone resistance due to fines
I_c :	Soil behavior type index
$S_{u(liq)}/\sigma'_v$:	Calculated liquefied undrained strength ratio
$S_{u(peak)}/\sigma'_v$:	Calculated peak undrained strength ratio

Procedure for the evaluation of soil liquefaction resistance, NCEER (1998)

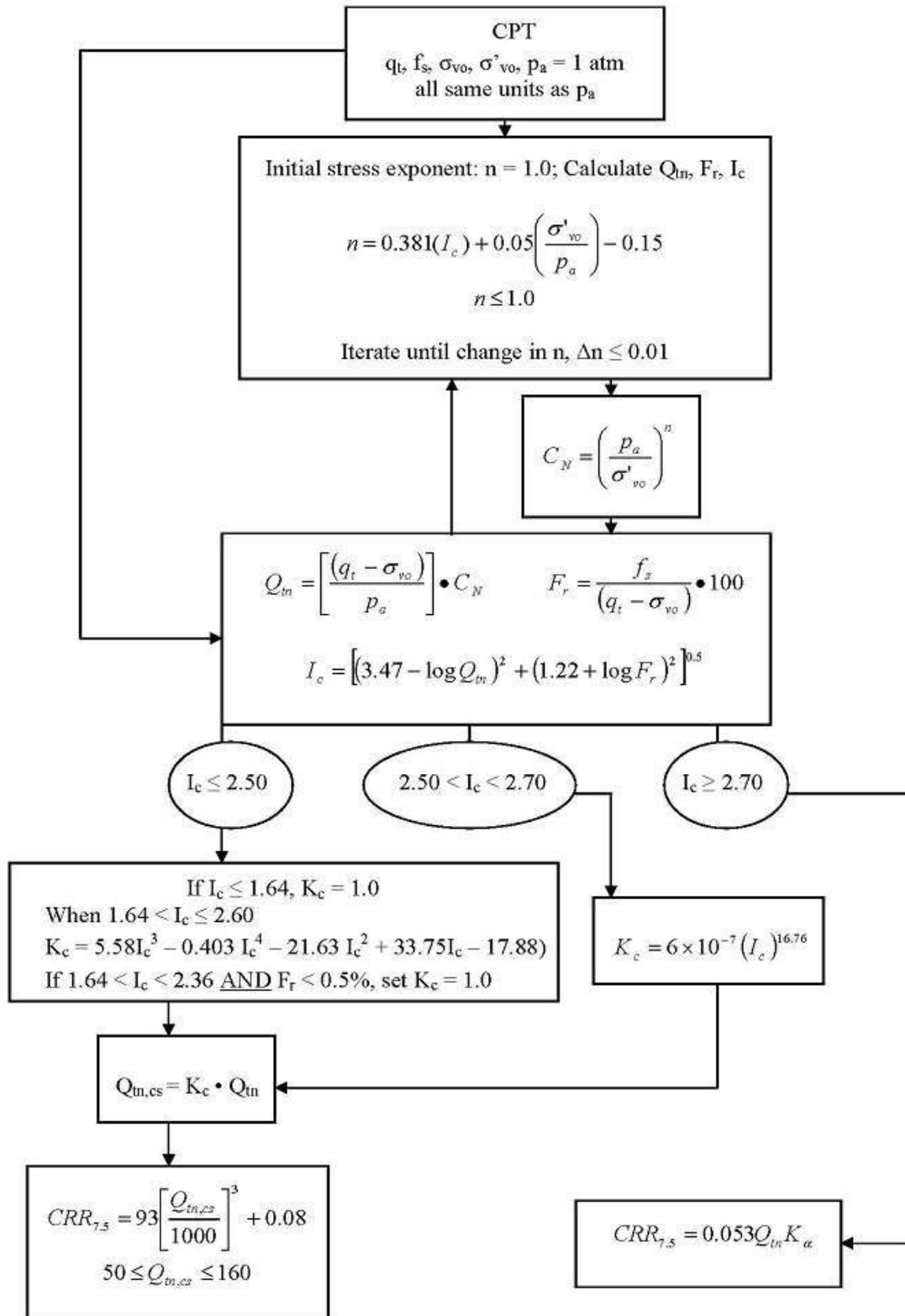
Calculation of soil resistance against liquefaction is performed according to the Robertson & Wride (1998) procedure. The procedure used in the software, slightly differs from the one originally published in NCEER-97-0022 (Proceedings of the NCEER Workshop on Evaluation of Liquefaction Resistance of Soils). The revised procedure is presented below in the form of a flowchart¹:



¹ "Estimating liquefaction-induced ground settlements from CPT for level ground", G. Zhang, P.K. Robertson, and R.W.I. Brachman

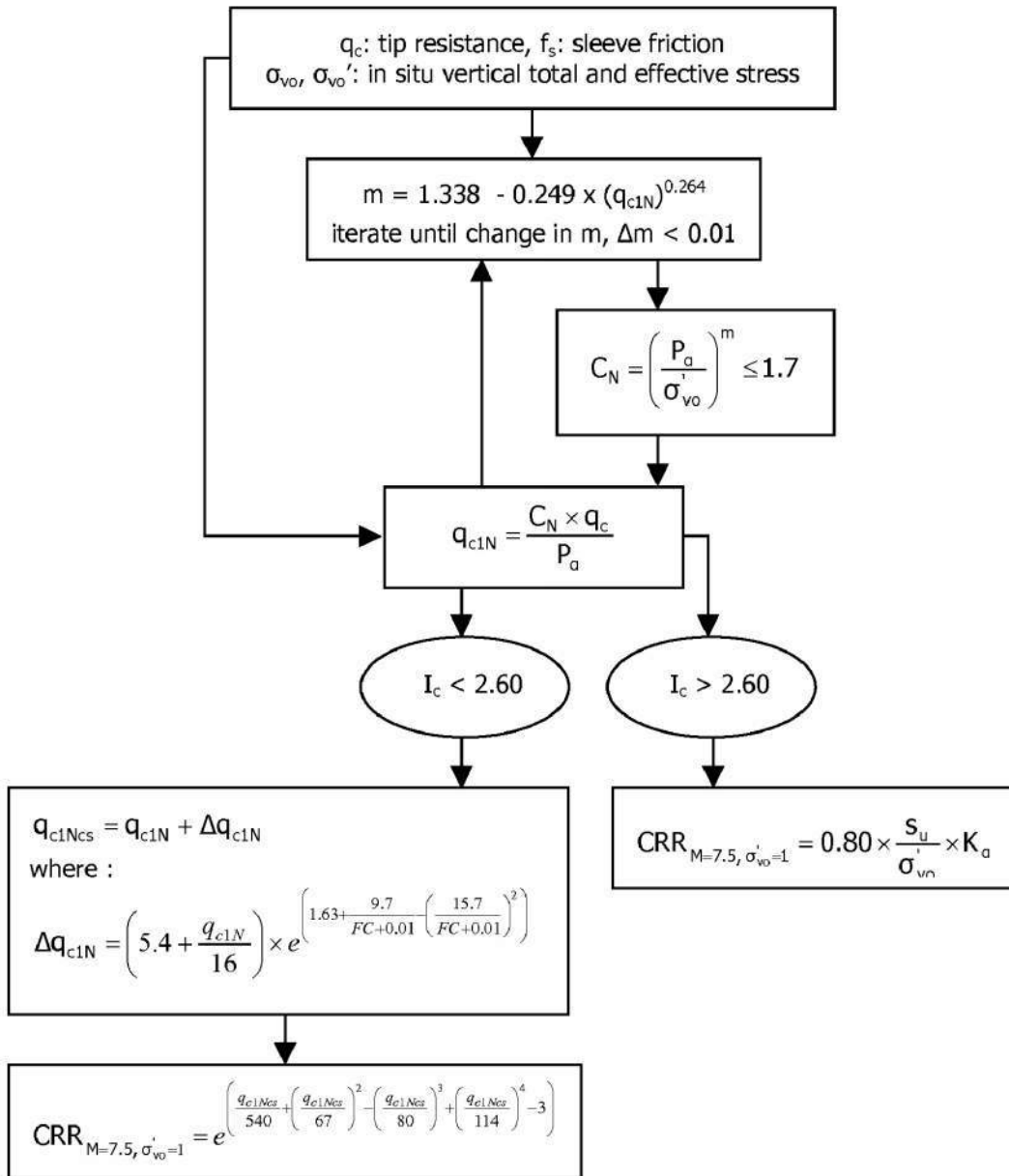
Procedure for the evaluation of soil liquefaction resistance (all soils), Robertson (2010)

Calculation of soil resistance against liquefaction is performed according to the Robertson & Wride (1998) procedure. This procedure used in the software, slightly differs from the one originally published in NCEER-97-0022 (Proceedings of the NCEER Workshop on Evaluation of Liquefaction Resistance of Soils). The revised procedure is presented below in the form of a flowchart¹:

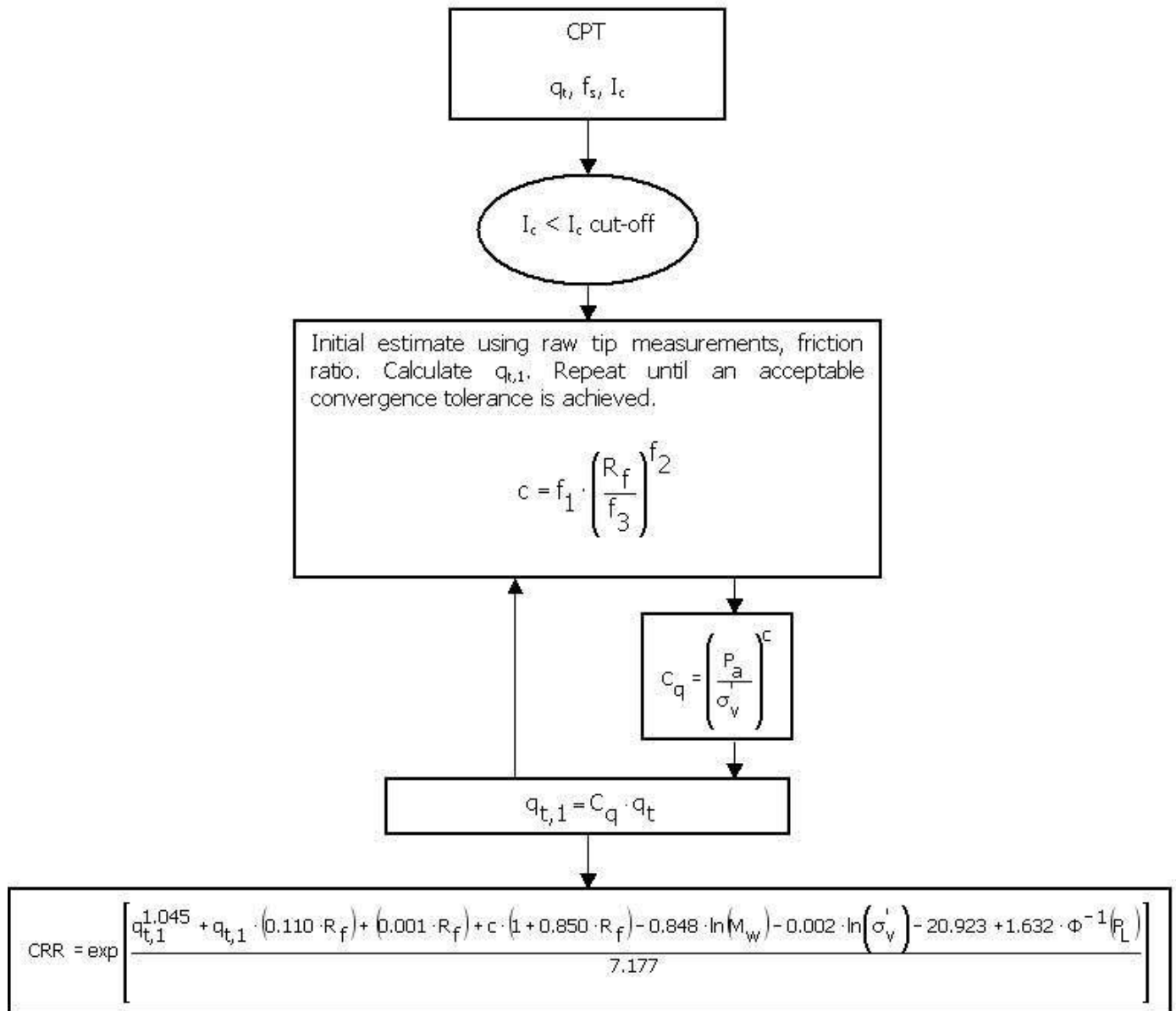


¹ P.K. Robertson, 2009. "Performance based earthquake design using the CPT", Keynote Lecture, International Conference on Performance-based Design in Earthquake Geotechnical Engineering – from case history to practice, IS-Tokyo, June 2009

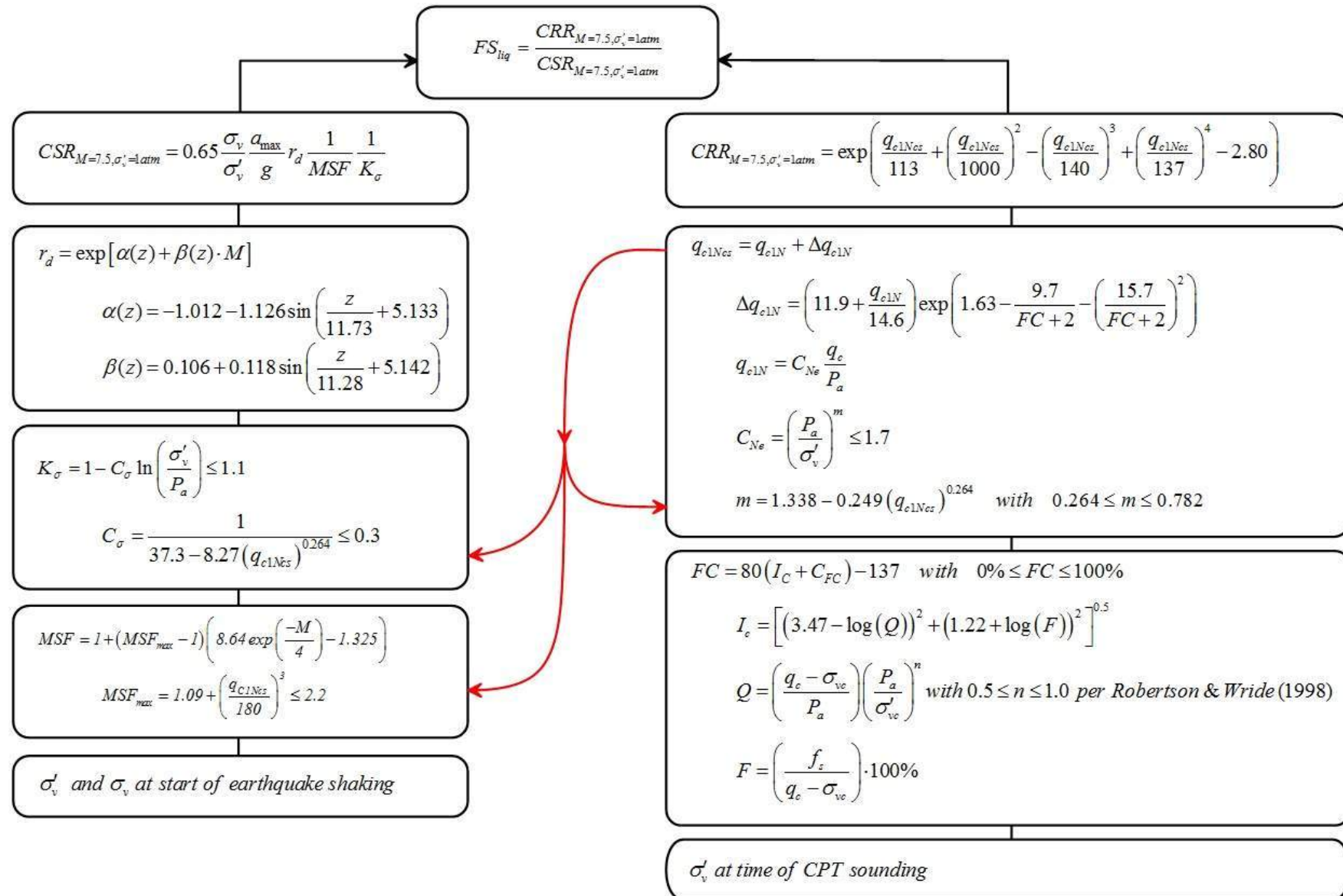
Procedure for the evaluation of soil liquefaction resistance, Idriss & Boulanger (2008)



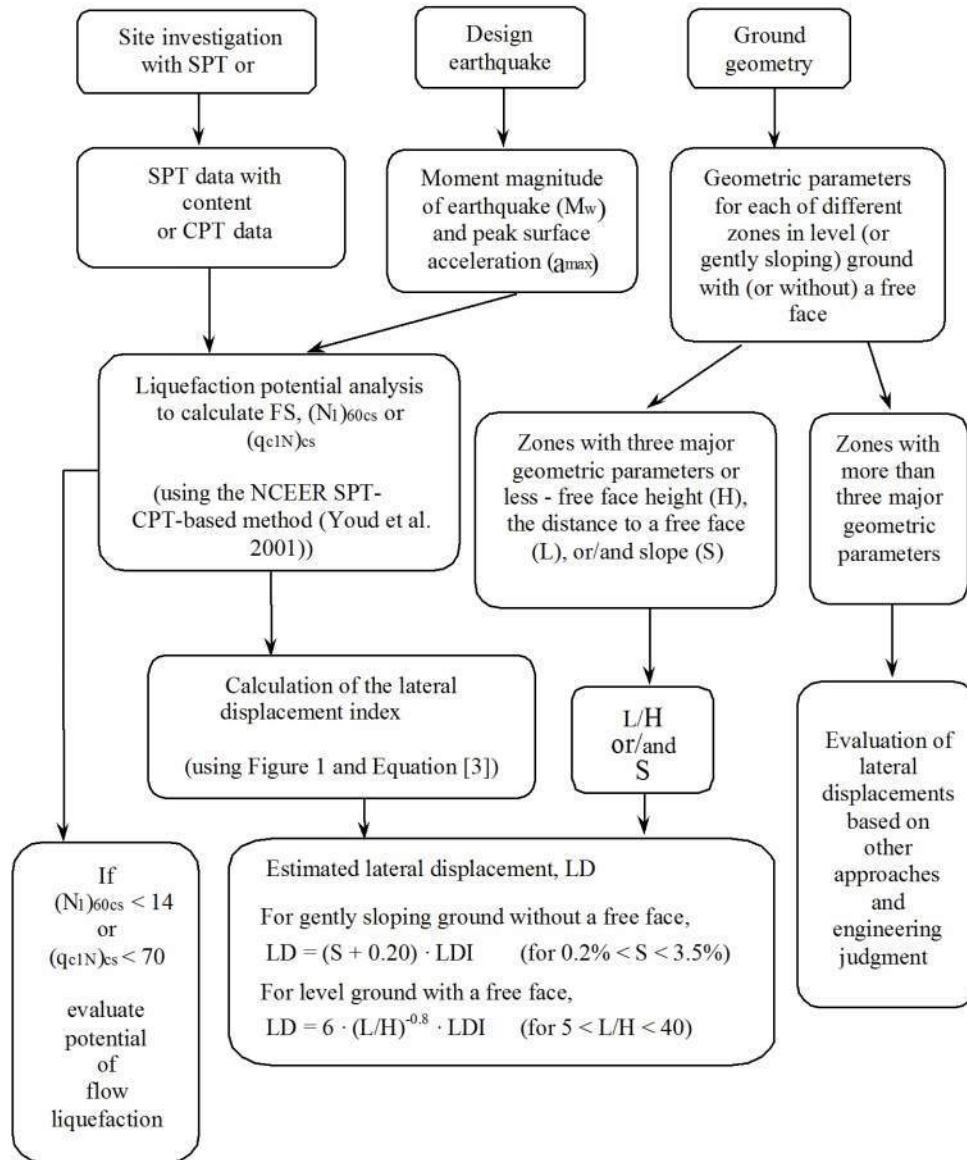
Procedure for the evaluation of soil liquefaction resistance (sandy soils), Moss et al. (2006)



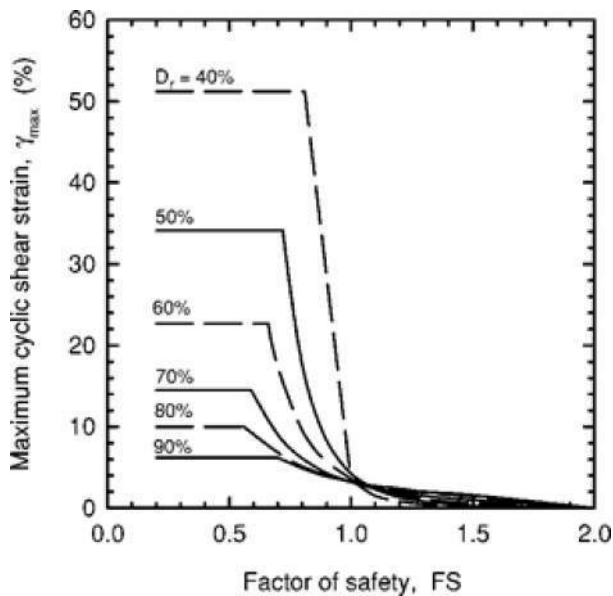
Procedure for the evaluation of soil liquefaction resistance, Boulanger & Idriss(2014)



Procedure for the evaluation of liquefaction-induced lateral spreading displacements



¹ Flow chart illustrating major steps in estimating liquefaction-induced lateral spreading displacements using the proposed approach



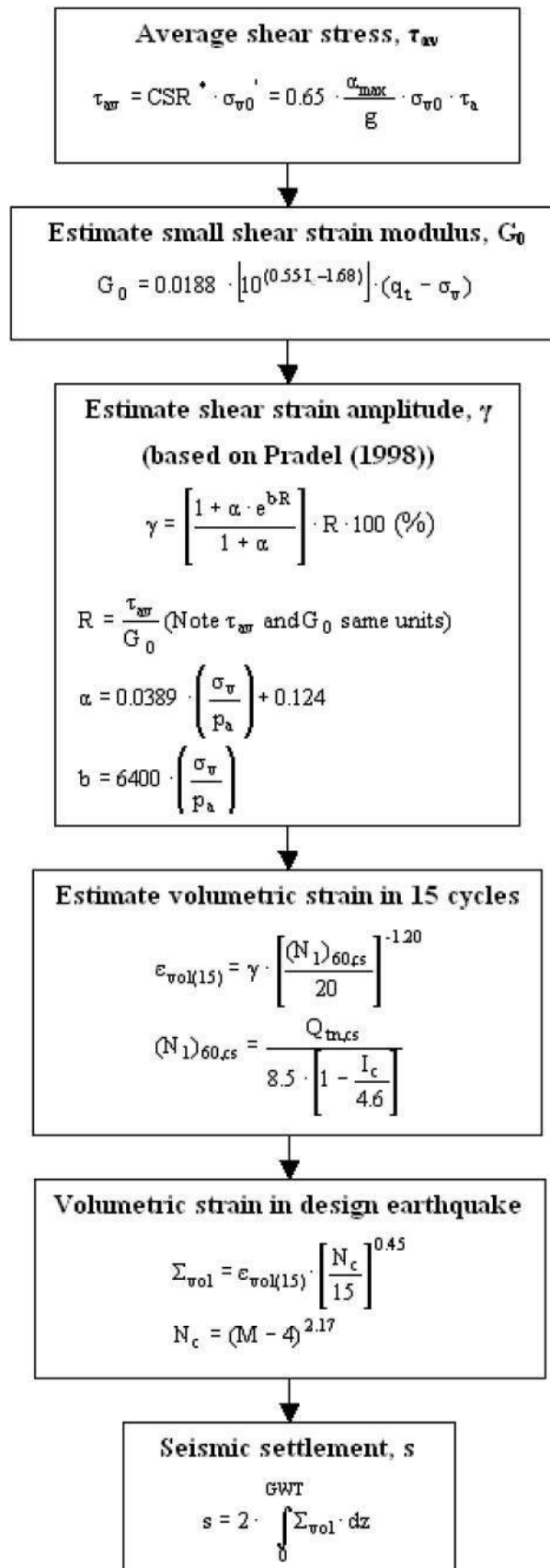
¹ Figure 1

$$LDI = \int_0^{Z_{max}} \gamma_{max} dz$$

¹ Equation [3]

¹ "Estimating liquefaction-induced ground settlements from CPT for level ground", G. Zhang, P.K. Robertson, and R.W.I. Brachman

Procedure for the estimation of seismic induced settlements in dry sands



Robertson, P.K. and Lisheng, S., 2010, "Estimation of seismic compression in dry soils using the CPT" FIFTH INTERNATIONAL CONFERENCE ON RECENT ADVANCES IN GEOTECHNICAL EARTHQUAKE ENGINEERING AND SOIL DYNAMICS, Symposium in honor of professor I. M. Idriss, San Diego, CA

Liquefaction Potential Index (LPI) calculation procedure

Calculation of the Liquefaction Potential Index (LPI) is used to interpret the liquefaction assessment calculations in terms of severity over depth. The calculation procedure is based on the methodology developed by Iwasaki (1982) and is adopted by AFPS.

To estimate the severity of liquefaction extent at a given site, LPI is calculated based on the following equation:

$$\text{LPI} = \int_0^{20} (10 - 0,5z) \times F_L \times dz$$

where:

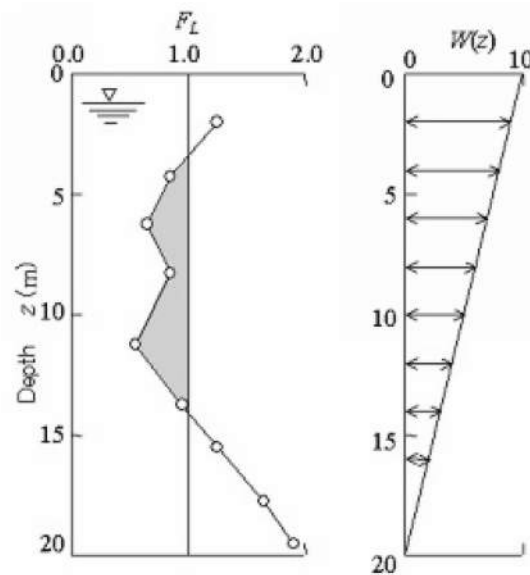
$F_L = 1 - \text{F.S.}$ when F.S. less than 1

$F_L = 0$ when F.S. greater than 1

z depth of measurement in meters

Values of LPI range between zero (0) when no test point is characterized as liquefiable and 100 when all points are characterized as susceptible to liquefaction. Iwasaki proposed four (4) discrete categories based on the numeric value of LPI:

- LPI = 0 : Liquefaction risk is very low
- $0 < \text{LPI} \leq 5$: Liquefaction risk is low
- $5 < \text{LPI} \leq 15$: Liquefaction risk is high
- LPI > 15 : Liquefaction risk is very high



Graphical presentation of the LPI calculation procedure

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APPENDIX E

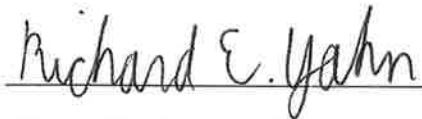
A Report Prepared for:

County of Humboldt
c/o Holmes Biord Architects
428 "C" Street
Eureka, CA 95501

**GEOTECHNICAL INVESTIGATION REPORT
HUMBOLDT COUNTY
NEW COURTS FACILITY
EUREKA, CALIFORNIA**

Kleinfelder Job No: 41-2467-01/001

by



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Reviewed by



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April 3, 1996

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TABLE OF CONTENTS

	<u>Page</u>
I. INTRODUCTION.....	1
A. Project Description.....	1
B. Purpose and Scope of Services	2
C. Authorization	2
II. SOIL INVESTIGATION.....	2
A. Site Description.....	2
B. Field Exploration	2
C. Laboratory Testing.....	4
D. Subsurface Conditions	4
III. FAULTING AND SEISMICITY	4
IV. CONCLUSIONS AND RECOMMENDATIONS	5
A. Conclusions	5
B. Recommendations.....	7
1. Site Preparation and Grading	7
2. Temporary Excavation and Backfill	8
3. Foundations and Below-Grade Walls	9
4. Concrete Slabs-on-Grade	10
5. Construction Dewatering	11
V. ADDITIONAL SERVICES	13
A. Project Bid Documents	13
B. Plan and Specifications Review.....	13
C. Construction Observation and Testing.....	13
D. Additional Copies of Report	14
VI. LIMITATIONS	14

APPENDIX

PLATES

- Plate 1 - Project Location Map
- Plate 2 - Site Plan
- Plate 3 - Boring Log Legend
- Plate 4 - Log of Exploration Boring KB-5
- Plates 5-12 - Log of Cone Penetrometer Soundings CPT-4 through CPT-11
- Plate 13 - Gradation Curves
- Plates 14-15 - Direct Shear Test Results
- Plate 16 - Lateral Pressure Influence Diagrams

BROCHURE

Important Information About Your Geotechnical Engineering Report

**GEOTECHNICAL INVESTIGATION REPORT
HUMBOLDT COUNTY
NEW COURTS FACILITY
EUREKA, CALIFORNIA**

I. INTRODUCTION

This report presents the results of Kleinfelder's geotechnical investigation for the proposed Humboldt County New Courts Facility project in Eureka, California. A map showing the location of the project site is presented on Plate 1 of the Appendix. We previously performed a geotechnical investigation for the Phase I and Phase II jail additions; results were presented in our August 12, 1993, and February 23, 1995 reports, respectively. The objective of this report is to provide the County of Humboldt (County) and their design team with findings, conclusions and recommendations regarding the geotechnical aspects of project development. This report was submitted in draft to the project team for review on March 28, 1995. The review comments were received on March 5, 1996 and incorporated into this report.

A. Project Description

The planned New Courts Facility project will be located east of both the under-construction Humboldt County Phase I jail addition and the proposed Phase II jail addition in downtown Eureka. The New Courts Facility will be 4 stories in height and will cover approximately 24,380 square feet of ground surface area. We further understand that the facility will have a basement beneath approximately two-thirds of its footprint, and will connect by a corridor with the east side of the currently under construction Phase I jail addition at the facility's second floor. The project site and configuration are shown on the attached Site Plan, Plate 2 of the Appendix.

We understand the New Courts Facility will be an interior concrete framed and perimeter shear wall structure with interior floor slabs over a basement parking garage. Total column loads will be on the order of 500 to 1,100 kips; total wall loads will be less than approximately 8 kips/lineal foot. We further understand that new site grading will require cuts on the order of 4 to 8 feet deep to establish a finished basement floor elevation of 40.57 feet (mean sea level datum). Additional details of the planned construction are not known. If actual loads or project considerations differ significantly from those indicated herein, we should be contacted to review and, if necessary, revise our recommendations.

B. Purpose and Scope of Services

The purpose of this investigation is to evaluate the proposed project development with respect to site soil characteristics and to provide opinions and recommendations concerning the following:

- Site preparation and grading,
- Geotechnical-related drainage,
- Excavation and backfill,
- Foundations,
- Slabs-on-grade,
- Lateral earth pressures,
- Faulting and seismicity.

The scope of our services, as outlined in our October 27, 1994 proposal, consisted of field exploration, laboratory testing, engineering analysis and preparation of this report.

C. Authorization

This investigation was authorized by County of Humboldt Purchase Order No. 19418, dated November 18, 1994. Coordination of this investigation for the County was through Holmes Bjord Architects and T. Y. Lin International (Structural Engineers).

II. SOIL INVESTIGATION

A. Site Description

The planned New Courts Facility project is located west of K Street, and east of the proposed Phase II jail addition and the currently under construction Phase I jail addition, in downtown Eureka. The project area to be developed is currently being used as a construction staging area for the Phase I jail addition. The project site slopes at a gradient of approximately 2.5 percent, descending to the north. The total elevation drop between 5th and 4th Streets, on the south and north sides of the project area, respectively, is approximately six feet.

B. Field Exploration

Our field exploration for the project was simultaneously conducted with the proposed Phase II jail addition project on December 20 through 22, 1994. The field exploration consisted of drilling one test boring and performing eight cone penetrometer test (CPT) soundings at the

approximate locations shown on the Site Plan, Plate 2 of Appendix. Drilling and CPT sounding points were located by pacing from features shown on the preliminary site plan prepared by Holmes Biord and Carkin Arbuckle Costic Architects, dated November, 1994. The new boring and CPT soundings were numbered consecutively from those borings and CPT soundings previously performed for the Phase I jail addition project (see Plate 2).

The test boring was drilled with a truck-mounted rig equipped with 4.25-inch diameter, hollow-stem augers utilizing rotary wash methods to a maximum depth of 31.5 feet below existing grade. Materials encountered in the test boring were visually classified in the field and a log was recorded by our field geologist. Visual classifications were made in accordance with the Boring Log Legend presented on Plate 3 of the Appendix. The Log of Exploration Boring KB-5 is presented on Plate 4 of the Appendix.

Relatively undisturbed samples were obtained within each major soil type by driving a two-inch inside diameter and two-and-a-half inch outside diameter Modified California Sampler containing thin brass liners into the bottom of the boring as it was drilled. The sampler was advanced by dropping a 140-pound hammer 30 inches per blow. The number of blows required to drive the last 12 inches of an 18 inch drive were recorded as penetration resistance in blows per foot (Blows/Ft) on the boring logs. When the sampler was withdrawn from the boring, the brass liners containing the samples were removed, examined for logging, labeled and sealed to preserve the natural moisture content for subsequent laboratory testing.

To supplement our new test boring, eight CPT soundings were also performed at the locations shown on the Site Plan, Plate 2 of the Appendix. The soundings were advanced to a maximum depth of approximately 35.4 feet below the present ground surface. An electronic cone penetrometer having a tip area of 10 square centimeters and an apex angle of 60 degrees was used in this sounding program. The cone penetrometer also contains a friction sleeve on its side having an area of 150 square centimeters. The cone penetrometer has separate load cells that record the tip resistance and sleeve friction as the cone is pushed through the soil profile at a rate of two centimeters per second. A near-continuous log of the tip resistance and sleeve friction is recorded. The tip resistance and friction ratio, which is the ratio between the sleeve friction and the tip resistance, are used to interpret engineering properties of the soil profile. Near-continuous logs of the CPT soundings are shown on the Log of CPT-4 through CPT-11, Plates 5 through 12 of the Appendix. The logs present the tip resistance and various interpreted soil engineering properties based on standard empirical methods.

C. Laboratory Testing

Laboratory tests were also performed on selected undisturbed soil samples to evaluate their physical characteristics and engineering properties. The testing program consisted of measurements of unit weight, moisture content, shear strength and grain size distribution. A summary of the laboratory test results are shown on the Log of Exploration Boring KB-5, Plate 4 of the Appendix. Graphic presentations of the test results for gradation and shear strength are also shown on Plates 13 through 15 of the Appendix.

D. Subsurface Conditions

The subsurface soils encountered in our boring and CPT soundings generally consist of medium dense to very dense sands with discontinuous interbedded thin lenses of sandy silts and clays. These interbedded layers of plastic, silty clay/clayey silt appear to range from approximately 1 to 2.5 feet thick within the upper approximately 8 feet of existing grade, and range in consistency from soft to medium stiff. The plastic silt/clay material was generally of medium stiff consistency and relatively thin (less than about 0.5 to 1-foot-thick) below this 8 foot depth. The soil profile indicated above appears to be consistent with our previous Phase I jail addition investigation (August, 1993) and the soil profile presented in the February 14, 1992, Kaldveer Associates geotechnical report for the seismic evaluation of the existing courthouse.

Ground water was encountered in current or previous Kleinfelder Borings KB-1, KB-2 and KB-5 at depths of 14, 15 and 8 feet below existing grades, respectively. Ground water was also previously recorded at the site by others at a depth of 9 feet below existing site grades, prior to the existing courthouse construction in 1958.

The above-described soil and ground water conditions encountered in the test boring and CPT soundings for this investigation have been simplified for ease of report presentation. A more detailed description of the conditions encountered are presented on the test boring and CPT logs enclosed in the Appendix.

III. FAULTING AND SEISMICITY

The site and the entire Northern California Coastal Region is seismically dominated by the presence of the active San Andreas Fault system and a series of faults north of Cape Mendocino.

In the theory of plate tectonics, the San Andreas fault system is the boundary between the northward moving Pacific Plate (west of the fault) and the southward moving North American Plate (east of the fault). The faults north of Cape Mendocino are predominantly west to northwest trending, northeast dipping, reverse and thrust faults which include the Little Salmon, Freshwater, Goose Lake, Mendocino, Fickle Hill, Mad River and McKinleyville, among others.

In the vicinity of the site, the active Fickle Hill Fault is located approximately 6.5 miles to the northeast, with the Little Salmon Fault and the Freshwater Fault located approximately 5.5 and 6.0 miles to the northeast of the site, respectively.

Although the site proper is not crossed by any mapped active faults, it will likely be subjected to a high degree of ground shaking from earthquakes generated on active faults in the Northern California area. Therefore, we recommend that the design and construction of the proposed structure conform to the requirements set forth in the most current issue of the Uniform Building Code for Seismic Zone No. 4 utilizing a site soil coefficient S_1 .

Other geologic hazards such as soil liquefaction, seismically-induced sea waves, landsliding, lateral spreading, differential compaction, ground cracking and flooding were evaluated by Kaldveer Associates in their February 14, 1992 geotechnical investigation report for seismic evaluation of the existing courthouse. This report appears valid for the current New Courts Facility project, and typically indicates a low to non-existent risk of these hazards affecting the project site.

IV. CONCLUSIONS AND RECOMMENDATIONS

A. Conclusions

Based upon data collected during this investigation, it is our opinion that the native soils underlying the site are considered adequate for the support of the anticipated New Courts Facility building loads. The primary geotechnical considerations for this project are total and differential foundation settlements resulting from the anticipated structural loads, ground water control during construction, and site preparation/grading for support of concrete slabs and pavements.

The near-surface soils, as previously discussed, contain relatively thick, soft to medium stiff silt/clay lenses to an approximate depth of eight feet. These upper soils containing soft plastic

clay/silt lenses will undergo erratic and detrimental settlement if relied upon to support the planned building foundation loads. The native sands (with some interbedded and discontinuous, thin silt/clay lenses) below about eight feet deep are considered suitable for support of the building loads utilizing relatively conventional spread footings.

We anticipate that footings bottoming in suitable bearing materials will require excavations of about 8 feet in depth (as measured from pre-Phase I jail addition site grades) at the project site. The excavations are anticipated to be at or below the observed ground water table. Flowing sands are anticipated in excavations extending below the water table, therefore, deep footing excavations should be shored and dewatered.

At a minimum, footings should extend to Elevation 38 (mean sea level datum) for basement portions, and to Elevation 40 for non-basement portions, to bear upon the denser native soils at a depth of approximately 8 feet below existing grades. If it is desired to bear footings at shallower depths, over-excavation of the weaker surface/backfill soils and replacement as engineered fill would most likely be required. The on-site soils are deemed suitable for reuse as engineered fill, if this alternative is chosen. Footings located adjacent to planned basement walls should extend below an imaginary 1:1 (feet horizontal:feet vertical) line extending up from the wall base to avoid subjecting the basement wall to an increase in lateral pressures imposed by the adjacent footing loads.

Total settlement of individual foundations will vary depending on the width of the foundation and the actual load supported. Foundation settlements have been estimated based on the anticipated structure loading conditions previously discussed. Maximum settlements of relatively shallow foundations designed and constructed in accordance with the recommendations presented herein are estimated to be less than one inch. Differential settlements between similarly loaded, adjacent footings are expected to be less than one-half this amount. The majority of the settlement is expected to occur during construction and the placement of dead loads.

Ground water at the site was observed at depths varying from 8 to 15 feet below existing grades between previous (1958) and our current investigation. Higher temporary perched ground water should also be anticipated following prolonged heavy seasonal rainfall.

Ground water may be encountered in excavations for footings; therefore, the contractor should be prepared to dewater the site during construction of the footings. Dewatering may also be

required for deep utility or basement excavations. The local ground water levels can fluctuate, however, depending on factors such as seasonal rainfall, ground water withdrawal and construction activities on this or adjacent properties. The influence of these time dependent factors was beyond the scope of our investigation.

B. Recommendations

1. Site Preparation and Grading

Grading plans were not finalized at the time this report was prepared. We anticipate that required grading will consist of cuts and fills of approximately four to eight feet in maximum vertical height to establish desired finished floor elevations. Final site elevations should be planned so that surface drainage is directed away from all foundations. Drainage gradients should be maintained to carry surface water off the site. Final grading plans should be reviewed by our firm for conformance to our design recommendations prior to construction bidding.

All surface and near-surface vegetation or debris, including construction rubbish and rubble, should be removed from the construction area. Following required excavations to achieve planned grades, subgrade soils beneath building and paved areas should be scarified to a depth of at least 6 inches. The scarified soils should then be moisture conditioned to within 2 percent of optimum moisture content and recompacted to at least 95 percent of maximum dry density. If weak surface or near-surface soils are overexcavated and replaced as engineered fill to support foundations, the bottom of the excavation should be "proof-rolled" with medium to heavy-duty earthwork equipment prior to the placement of engineered fill. Where soft or yielding subgrade soils are observed during proof-rolling, further overexcavation to expose firm materials will be required.

Engineered fill should be placed in lifts no greater than eight inches in loose thickness and compacted to at least 90 percent of maximum dry density at or within 2 percent of optimum moisture content. All compaction requirements stated in this report refer to dry density and moisture content relationships obtained through the laboratory standard described by ASTM D-1557-91.

All permanent cut and fill slopes should be no steeper than two feet horizontal to one-foot vertical (2:1). Temporary cut slopes above the water table can be constructed at 1:1 gradient.

Cut slopes below the water table should be shored, or the ground water should be drawn down to an elevation at least two feet below the bottom of the excavation.

We recommend that imported engineered fill, if required, be of a low to non-expansive nature and meet the following criteria:

Plasticity Index	less than 15
Liquid Limit	less than 40
Percent Soil Passing #200 Sieve	between 15% and 45%
Maximum Aggregate Size	3 inches

Grading operations during the wet season or in areas where the soils are saturated, will require drying of the soil prior to achieving adequate compaction. If the project necessitates fill placement and compaction in wet conditions, we could provide alternatives for drying the soils. Conversely, additional moisture may be required during the dry months. Water trucks or equivalent water sources should be available in sufficient number to provide water during compaction operations in the dry months.

All site preparation and grading operations should be observed by a representative of Kleinfelder. During the excavation/scarification processes, a representative of our firm should especially be present to observe whether unforeseen weak, yielding materials are encountered in the construction area and to test subsequent compaction of subgrade soils or engineered fills.

2. Temporary Excavation and Backfill

Relatively shallow excavations for footings and utility trenches can be readily made with either a backhoe or trencher; larger earth-moving equipment should be used for the more extensive or deeper required excavations. We expect the walls of trenches less than approximately ten feet deep to remain relatively stable during construction at temporary 1:1 gradients provided equipment or excavated spoil surcharges are not located near the top of the trench excavations. Where trenches are extended deeper than about ten feet and below the groundwater level, the excavation will likely be unstable. All trenches, regardless of depth, should be evaluated for stability prior to personnel entering them. Shoring or sloping and dewatering of trench excavations deeper than about five feet will likely be necessary to protect personnel and to provide stability. All trenching operations should conform to the current CAL-OSHA requirements for worker safety.

We recommend a minimum compaction of native trench backfill to 90 percent of maximum dry density. The upper 6 inches of trench backfill should be further compacted to a minimum of 95 percent of maximum dry density beneath structures. The moisture content of compacted backfill soils should be within 2 percent of optimum.

3. Foundations and Below-Grade Walls

We understand that building loads will be transmitted to supporting soils through isolated column and/or continuous wall spread footings. Based on the data collected during this investigation, building loads may be adequately supported by spread footings bearing upon either native soils or engineered fill at Elevations of at least 38 to 40 feet. Local deepening or overexcavation should be anticipated where isolated, thin zones of weak or yielding bearing soils are encountered. Allowable soil bearing pressures for footings supported upon firm native or engineered fill soils are as follows:

<u>Footing Bottom Grade</u>	<u>Allowable Bearing Pressures (psf)</u>		
	<u>Dead Load</u>	<u>Dead + Live Load</u>	<u>Total Load</u>
Elevation 40	3,200	4,000	4,800
Elevation 38	4,800	6,000	7,200

The allowable soil bearing pressures are net values. The weight of the foundation concrete and backfill over the foundation may be neglected when computing dead loads.

Resistance to lateral forces may be computed using friction and passive pressure. A friction factor of 0.40 is recommended between the undersurface of concrete structures and the supporting soils. A passive pressure equivalent to that exerted by a fluid weighing 350 pounds per cubic foot (pcf) is recommended against the face of foundations. If friction and passive pressure resistance are combined, the larger value should be reduced by 50 percent.

Lateral earth pressures for design of below-grade walls were presented in the previous Kaldveer Associates report (February, 1992) for the existing courthouse building. We recommend these pressures, as clarified or modified below, also be used for design of below-grade walls for the proposed facility.

Existing and any new below-grade walls must be capable of resisting both lateral earth pressures and any additional lateral loads caused by surcharging (such as vehicle loads) or seismic forces.

Restrained below-grade walls should be capable of resisting an equivalent fluid pressure of 50 pcf plus an additional uniform pressure of $14H$ where H equals the wall height for dynamic (earthquake) loads. An additional 20 pcf should be added to these pressures to account for hydrostatic forces in the absence of wall backdrains. These pressures assume a level backfill exists adjacent to the wall and do not account for surcharge loads. Below-grade walls subjected to surcharge loads should be designed for additional lateral pressures as presented on Plate 16 of the Appendix.

Footing concrete should be placed neat against undisturbed soil, if possible. The soils exposed in footing excavations should not be allowed to dry before placing concrete. If shrinkage cracks appear in the footing excavation soils, these soils should be thoroughly moistened to close all cracks prior to concrete placement. We should observe all footing excavations prior to placement of concrete to check that the conditions exposed are as anticipated, or to modify our recommendations, if necessary.

4. Concrete Slabs-on-Grade

Concrete slabs-on-grade for this project will consist of the building basement and ground floors, and exterior walkways.

The near surface soils are generally sandy silts/silty sands and have a low potential for shrink/swell cycles with fluctuations in moisture content. These soils generally provide stable slab support when properly prepared.

Subgrade soils for concrete floor slabs and exterior walkways should be prepared by scarifying them to a depth of 6 inches, and then recompacting these soils to at least 95 percent relative compaction at or within 2 percent of optimum moisture content.

Concrete slabs-on-grade should be supported on at least four inches of slab base rock to provide a capillary moisture break from the underlying soil. This rock should be graded such that 100 percent passes the one-inch sieve and no more than 5 percent passes the No. 4 sieve. We recommend that this material be placed as soon as possible after compaction of the soil subgrade to reduce the risk of drying or disturbance of subgrade soils. If the subgrade soils are allowed to dry out prior to concrete slab-on-grade construction, these soils should be re-moisture conditioned by sprinkling until covered by slab base rock.

We recommend that interior floor slabs be a minimum of five inches thick and be reinforced according to the recommendations set forth by the structural engineer. Care should be taken to install reinforcement at the slab mid-height, particularly when using welded-wire fabric. Floor slabs should be underlain by at least 6 inches of slab base rock where subject to vehicular traffic.

Moisture vapor will likely condense beneath concrete slab-on-grade floors. For interior floor slabs with moisture sensitive surfacing, we recommend that an impermeable membrane (such as heavy plastic sheeting) be placed over the slab base rock to reduce the risk of moisture vapor migration through the concrete. In order to promote a more uniform curing of the slab and to reduce the risk of membrane puncture, it is usually advisable to place 2 inches of fine sand on top of the membrane prior to placing the slab concrete; the sand should be kept moist until concrete is placed.

5. Construction Dewatering

Excavations which extend below the site ground water level (currently estimated to be at approximate elevations of 34 to 40, but subject to variations) will need to be dewatered. To maintain stability of the excavation bottom, ground water levels should be drawn down a minimum of 2 feet below the lowest portion of required excavation, including foundations. The ground water level should be maintained below this recommended level until the foundations and structure backfill have been completed to an elevation of at least 2 feet above the pre-dewatering ground water elevation.

Specific analysis of contractor dewatering needs or the design of contractor dewatering systems was beyond the scope of our investigation services. This work is best accomplished by a competent dewatering subcontractor. Some discussion of potential dewatering methods is presented herein to preliminarily facilitate the contractor's design.

Several methods of dewatering can most likely be used. These include well points, deep wells, and sheet-pile cutoffs (in combination with sumps, well points, or deep wells). The method ultimately selected is dependent on a number of factors, e.g., quantity of ground water to be removed, cone of depression (zone of influence) of dewatering measures within the construction area, stability of the near-surface silty and fine sands, the presence of potential seepage zones which will pipe water from distant sources after the ground water table is lowered, and cost.

Collection of ground water and seepage in open or sheeted sumps without filters, while perhaps appearing less expensive, have disadvantages which the contractor will have to address: 1) silty and fine sands are sensitive to seepage pressures, and 2) slope instability and loss of strength in the sump bottom are likely with open pumping. In addition, if upward seepage occurs in the sump bottom, a 1- to 2-foot filter layer of gravel and/or coarse sand should be used.

Sheet piling is sometimes used to support excavation walls, provide lateral ground water cutoff, lower the amount of dewatering, and mitigate heave of excavation bottoms. However, sheet piling is most often used where a definite impermeable bedrock or clay underlies the construction area; we preliminarily estimate that a positive lateral cutoff of ground water will be difficult to achieve within the upper approximately 50 feet of surface and near-surface soils at the site. Further, positive dewatering methods, such as well points at close intervals or a number of deep wells, will still likely be required when using sheet piling.

Well points offer good flexibility as a dewatering method over a range of granular soils, but typically have a suction lift limitation of 20 feet for single stages. This depth limitation may require multiple well point stages and placement of the system at the bottom of excavations, or partially up excavation slopes, which may hamper construction operations and backfilling. Deep wells are generally well-suited to clean sands and gravels without the suction lift limitations of well points. However, the relative ability of deep wells to dewater stratified soils and silty or clayey sands is fair to poor in comparison to well points. Normal spacing for well points is on the order of 5 to 10 feet; deep wells are normally spaced in excess of 50 feet. Pumping rates are uncertain because no pump test data is understood to be available for the site.

The North Coast Regional Water Quality Control Board is likely to restrict the discharge of water pumped from excavations extending below the ground water table. Temporary construction dewatering will require an NPDES permit for discharge unless the water is discharged to the sanitary sewer system, which will still require approval from the City of Eureka.

Lowering the ground water table could induce settlements of the dewatered and underlying soils. If structures or utilities are located within the anticipated cone of depression, ground water levels, settlement, and deflections at and near the structure or utility should be monitored during dewatering to observe if the ground water level is changing and movement is occurring. Dewatering should stop and appropriate corrective action should be taken if settlement or changes in ground water levels are noted at these critical points.

We recommend that the project specifications clearly state that subgrade or foundation bottom instability is likely in construction areas where ground water is shallow. The specifications should be worded so that the contractor is responsible for dewatering, obtaining any necessary discharge permits and correcting unstable subgrade or foundation bottom instability.

V. ADDITIONAL SERVICES

A. Project Bid Documents

It has been our experience that contractors bidding on projects often contact us to discuss the geotechnical-related aspects. Informal contacts between Kleinfelder and an individual contractor could result in incomplete or misinterpreted information being provided to the contractor. Therefore, we recommend a pre-bid meeting be held to answer questions about this report prior to submittal of bids. If this is not possible, questions or clarifications regarding this report should be directed to the project Owner or his designated representative. After consultation with Kleinfelder, the project Owner (or his representative) should provide clarifications or additional information to all contractors bidding the job.

B. Plan and Specifications Review

Continued coordination between the project design team and the geotechnical engineer is recommended to check that the design is compatible with the soil and ground water conditions determined by this investigation.

We recommend our firm conduct a general review of final plans and specifications to evaluate that our earthwork and foundation recommendations have been properly interpreted and implemented. In the event that we are not retained to perform this recommended review, we cannot assume responsibility for misinterpretation of our recommendations.

C. Construction Observation and Testing

We recommend that earthwork-related construction be monitored by a representative from our office, including, but possibly not limited to:

- Site preparation and over-excavation of weak surface or near-surface soils;
- Placement and compaction of engineered fill and trench backfill;
- Subgrade preparation for concrete slabs;
- Excavation for foundations.

The purpose of these services would be to provide Kleinfelder the opportunity to check the applicability of the recommendations presented in this report to the soil and ground water conditions actually encountered during construction. If necessary, we can recommend appropriate changes in design or construction procedures where actual conditions differ from those described herein.

D. Additional Copies of Report

We have provided the County of Humboldt (c/o Holmes Biord Architects) with six bound copies of this report. If additional copies are required, we can provide copies at an additional fee (in accordance with our current fee schedule) after receipt of a written request from our Client. **Under no circumstances will we provide a copy of the report to other design consultants or contractors without written permission from our Client.**

The above additional services are not included as part of our contract for this investigation but can be provided by our firm when requested.

VI. LIMITATIONS

The recommendations contained in this report are subject to the limitations presented herein. In addition, a brochure prepared by ASFE (Association of Firms Practicing in the Geosciences) has been included in the Appendix of this report. We recommend that all individuals reading this report also read this attached brochure.

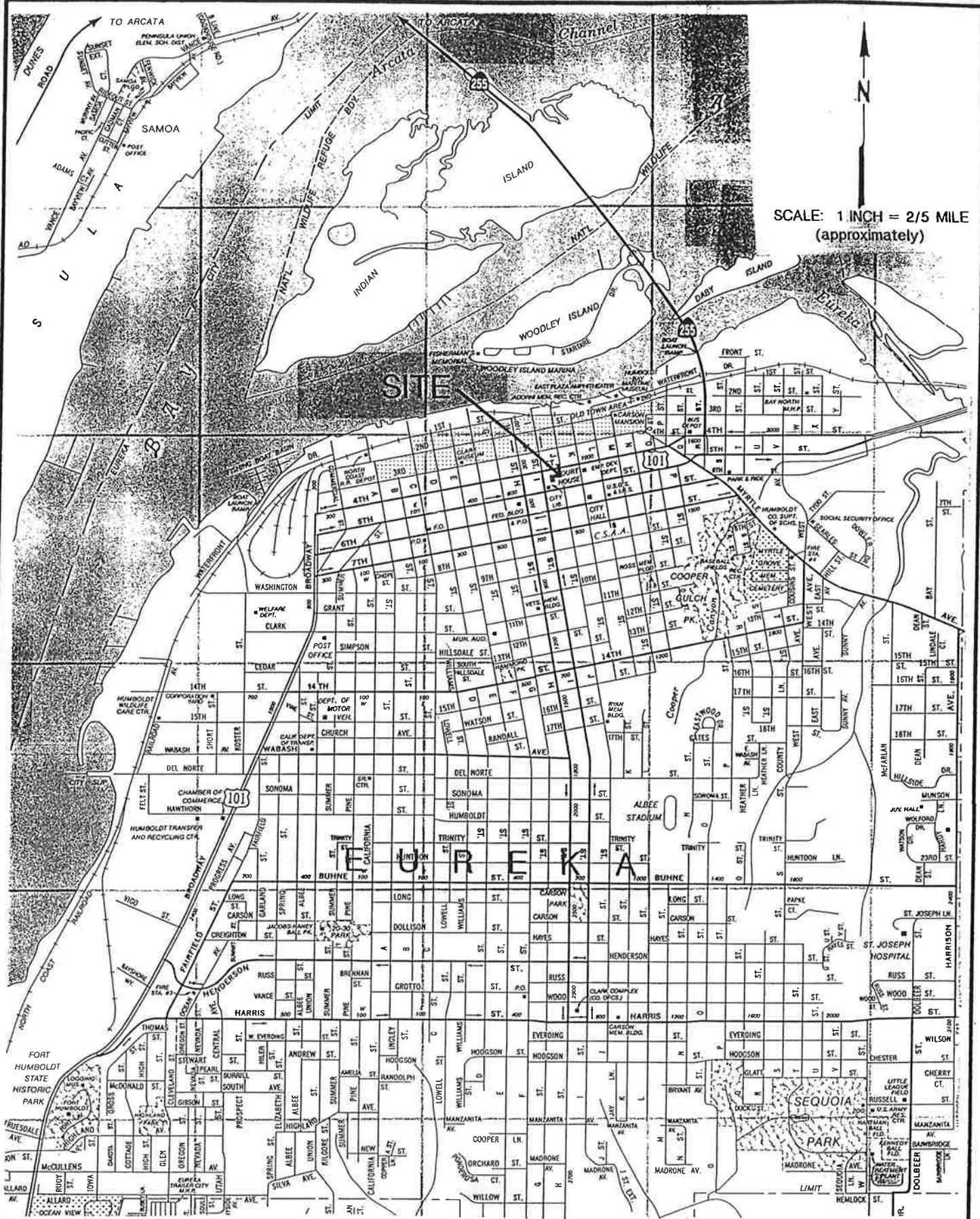
Recommendations contained in this report are based on our field observations; data from exploratory borings, cone penetrometer test soundings and laboratory tests; and our present knowledge of the proposed construction. It is possible that subsurface conditions could vary between or beyond the points explored. If soil and ground water conditions are encountered during construction which differ from those described herein, our firm should be notified in order that a review may be made and supplemental recommendations provided, if necessary. If the

scope of the proposed construction, including the proposed loads, grades, or structure locations, changes from that described in this report, our recommendations should also be reviewed and modified, if necessary.

Our firm has prepared this report for the exclusive use of our Client and their design team on this project in substantial accordance with the generally accepted geotechnical engineering practice as it exists in the site area at the time of our investigation. No warranty is expressed or implied. The recommendations provided in this report are based on the assumption that an adequate program of tests and observations will be conducted by our firm during the project construction phase in order to evaluate compliance with our recommendations. If Kleinfelder is not retained for these services, our Client cannot hold us responsible for potential claims that may arise during or after construction.

This report is issued with the understanding that our Client chooses the risk they wish to bear by their chosen design approach, and construction expenditures and scheduling. It is our Client's responsibility to see that all parties to the project, including the designer, contractor, subcontractors, etc., are made aware of this report in its entirety including the Additional Services and Limitations sections.

PLATES



SCALE: 1 INCH = 2/5 MILE
(approximately)

Base map by CSAA.



PROJECT LOCATION MAP
Humboldt County Courthouse
Eureka, California

PLATE

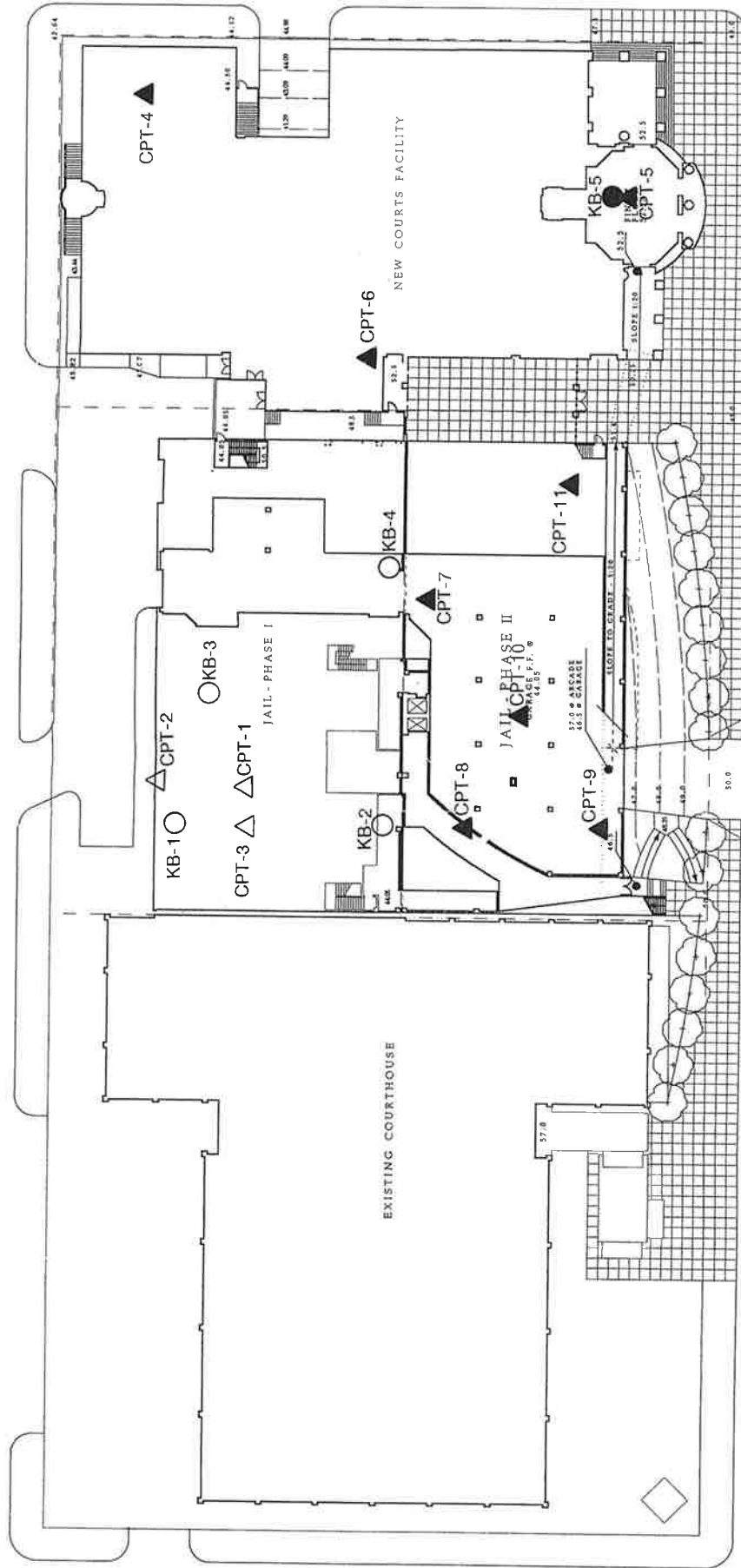
1

PROJECT NO. 41-2467-01-001

FOURTH STREET

I STREET

K STREET



LEGEND

- KB-5
- KB-4
- ▲ CPT-11
- △ CPT-3

- approximate location of boring (12-94)
- approximate location of boring (6-93)
- ▲ approximate location of cone penetration test (12-94)
- △ approximate location of cone penetration test (7-93)

scale: 1 inch = 40 feet



SITE PLAN
Humboldt County Courthouse
Eureka, California

PLATE

2

PROJECT NO. 41-2467-01-001

Reference: Site Plan dated November, 1994 by Holmes - Biord Architects.

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS		SYM	LTR	DESCRIPTION	MAJOR DIVISIONS	SYM	LTR	DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS		GW	Well-graded gravels or gravel sand mixtures, little or no fines.	FINE GRAINED SOILS		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
			GP	Poorly-graded gravels or gravel sand mixture, little or no fines.			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
			GM	Silty gravels, gravel-sand-silt mixtures.			OL	Organic silts and organic silt-clays of low plasticity.
			GC	Clayey gravels, gravel-sand-clay mixtures.			MH	Inorganic silts, micaceous or diatomaceous fine or silty soils, elastic silts.
	SAND AND SANDY SOILS		SW	Well-graded sands or gravelly sands, little or no fines.			CH	Inorganic clays of high plasticity, fat clays.
			SP	Poorly-graded sands or gravelly sands, little or no fines.			OH	Organic clays of medium to high plasticity.
			SM	Silty sands, sand, and silt mixtures.			PI	Peat and other highly organic soils.
			SC	Clayey sands, and clay mixtures.		HIGHLY ORGANIC SOILS		

	Disturbed bag or bulk sample		LL	Liquid limit
	Standard penetration split spoon sample		PI	Plasticity index
	Modified California sample		%-#200	Percent of soil passing the #200 sieve
	Shelby tube sample		R-Value	Resistance value
	Water level observed in boring (at time of drilling)		EI	Percent of swell as measured by UBC Standard No. 29-2
	Water level observed in boring (at given post-drilling time)		C	Soil cohesion in psf
			phi	Angle of internal friction

NOTES: Blow counts represent the number of blows of a 140-pound hammer falling 30 inches required to drive a sampler the last 12 inches of an 18-inch penetration.

The lines separating strata on the logs represent approximate boundaries only. The actual transition may be gradual. No warranty is provided as to the continuity of soil strata between borings. Logs represent the soil strata observed at the boring location on the date of drilling only.

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KLEINFELDER
Geotechnical, Materials and Environmental Engineering

BORING LOG LEGEND

PLATE

**Humboldt County Courthouse
Eureka, California**

3

PROJECT NO. **41-2467-01-001**

LABORATORY				FIELD		Lithology	U.S.C.S. Designation	SOIL DESCRIPTION
Dry Density pcf	Moisture Content %	Compress. Strength ksf	Other Tests	Blows/ft	Sample			
103	16		%-#200=22	39		0-5	SM-M SM	SAND/SILT - dark brown, medium dense(stiff), moist, fine grained (topsoil)
109	19		phi=30 C=400	15 25		5-10	SM	SILTY SAND - orange, dense, moist, fine grained, weak cementation (ferric-oxide) SILTY SAND - beige with orange mottling, medium dense, very moist, fine grained
105	22		%-#200=15	84		10-15	SP-SM	SAND - beige to gray with orange mottling, very dense, wet, fine grained, thinly bedded with variable silt content
108	19		phi=33 C=250	21		15-20	CL SP-SM	SANDY CLAY - yellow-brown, stiff, very moist, fine grained SILTY SAND - gray, dense, wet, fine grained, occasional organic debris, thinly bedded layers with variable silt content
101	23		%-#200=32	47		20-25	SC-SM SP-SM	CLAYEY/SILTY SAND - brown, dense, very moist, fine grained, abundant organic material in very thin layers SILTY SAND - gray, dense, wet, fine grained, occasional organic debris, thinly bedded layers with variable silt content
103	21		%-#200=6	65		25-30		
114	17		%-#200=34	24		30-31.5		blue-gray, slightly clayey
Boring terminated at 31.5 feet. Ground water encountered at 8.5 feet.								

SURFACE ELEVATION: feet
TOTAL DEPTH: 31.5 feet
GROUND WATER DEPTH: ∇ at time of drilling
 ∇ +1 hr

LOGGED BY: John L. Finnigsmier
EQUIPMENT: CME 550, rotary wash
DIAMETER of BORING: 4.25 inches
DATE DRILLED: 12-20-94



Humboldt County Courthouse
Eureka, California

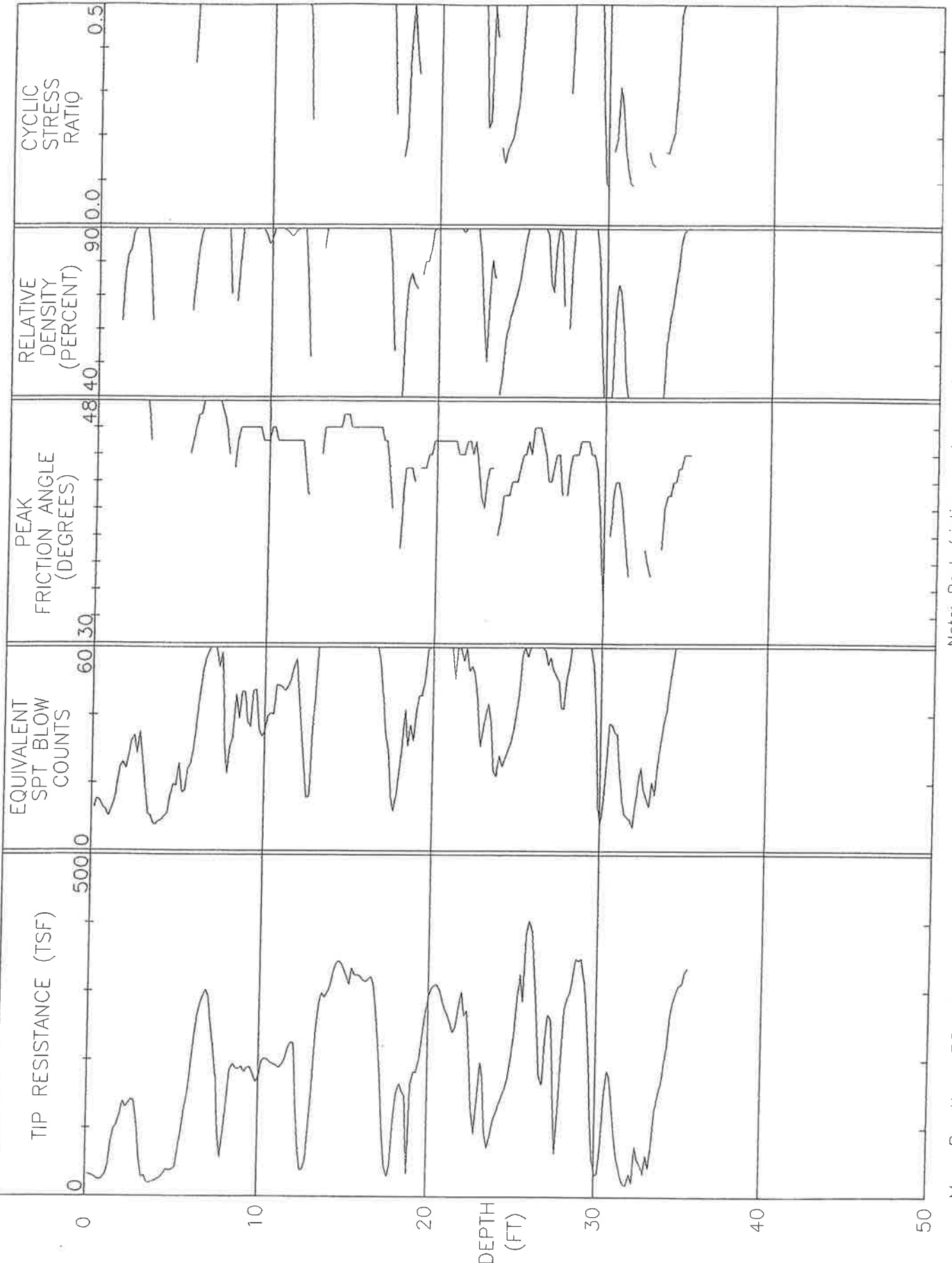
PLATE
4

PROJECT NUMBER 41-2467-01-001 December 1994

LOG OF EXPLORATION BORING
KB-5

1 of 1

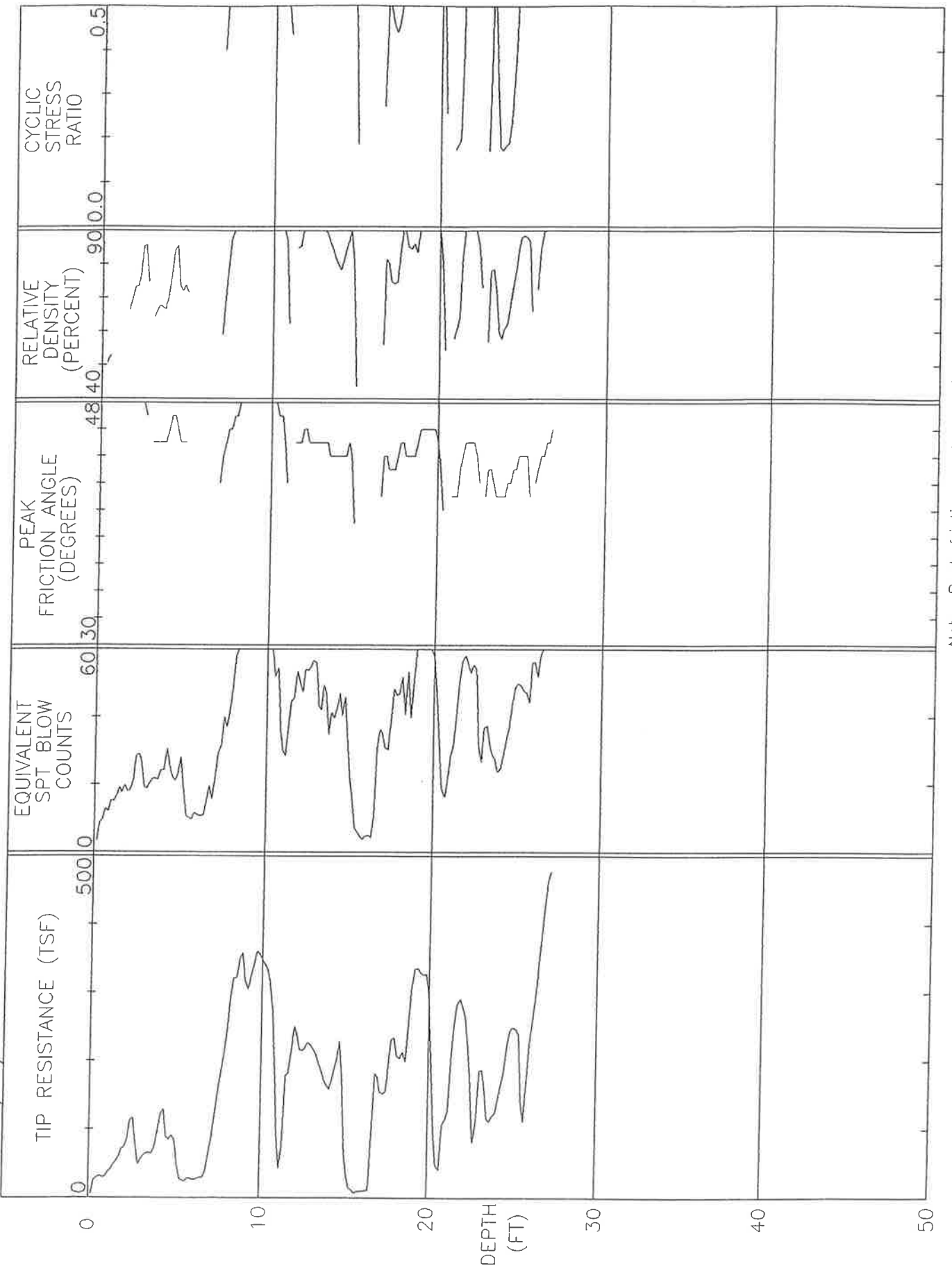
Location: CPT 4A
 Job #: 41-2467-01
 Date: 12/19/94



Note: Peak friction angle, relative density, and cyclic stress ratio are undefined for cohesive soils. Cohesive data points are not plotted.

Max Depth: 35.43 Feet

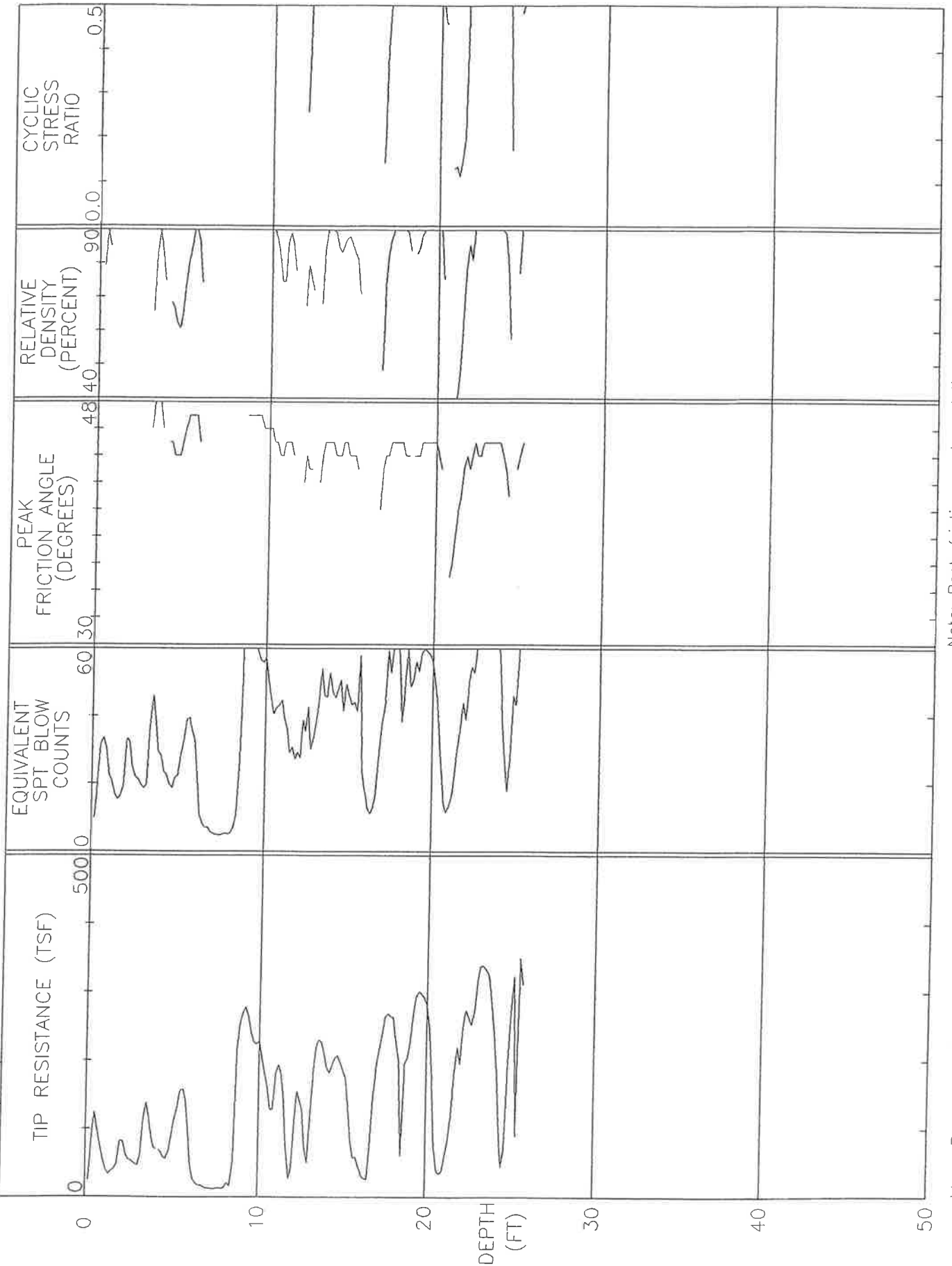
Location: CPT 5
 Job #: 41-2467-01
 Date: 12/19/94



Note: Peak friction angle, relative density, and cyclic stress ratio are undefined for cohesionless soils.

Max Depth: 27.07 Feet

Location: CPT 6
 Job #: 41-2467-01
 Date: 12/19/94



Max Depth: 25.59 Feet

Note: Peak friction angle, relative density, and cyclic stress ratio are undefined for cohesive soils. Cohesive data points are not plotted.



KLEINFELDER

PROJECT NO. 41-2467-01-001

Job No: 41-2467-01
 Appr:
 Drwn: RNL
 Date: 12/22/94

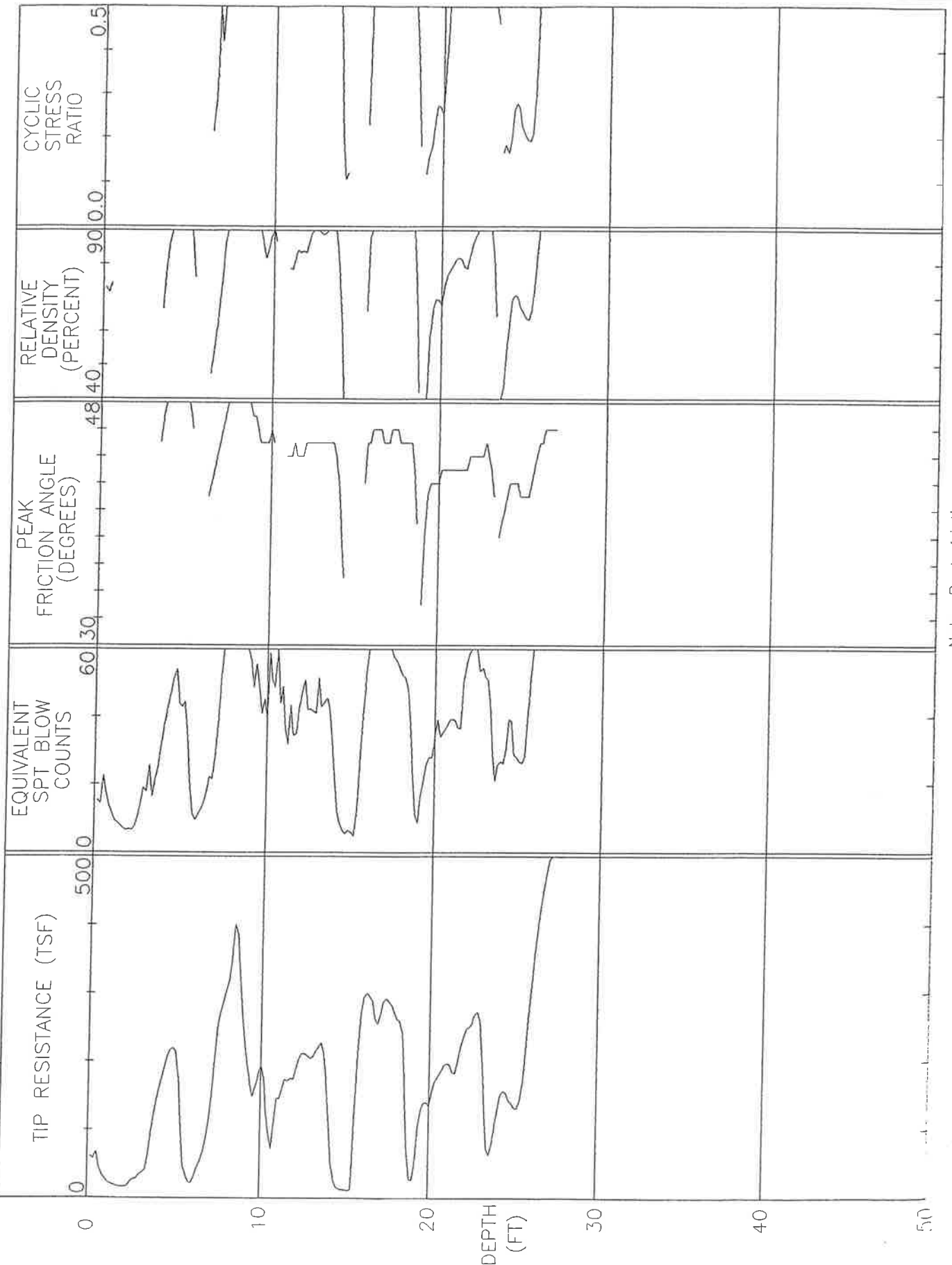
LOG OF CPT 6

HUMBOLDT COUNTY COURTHOUSE
 EUREKA, CA

PLATE

7

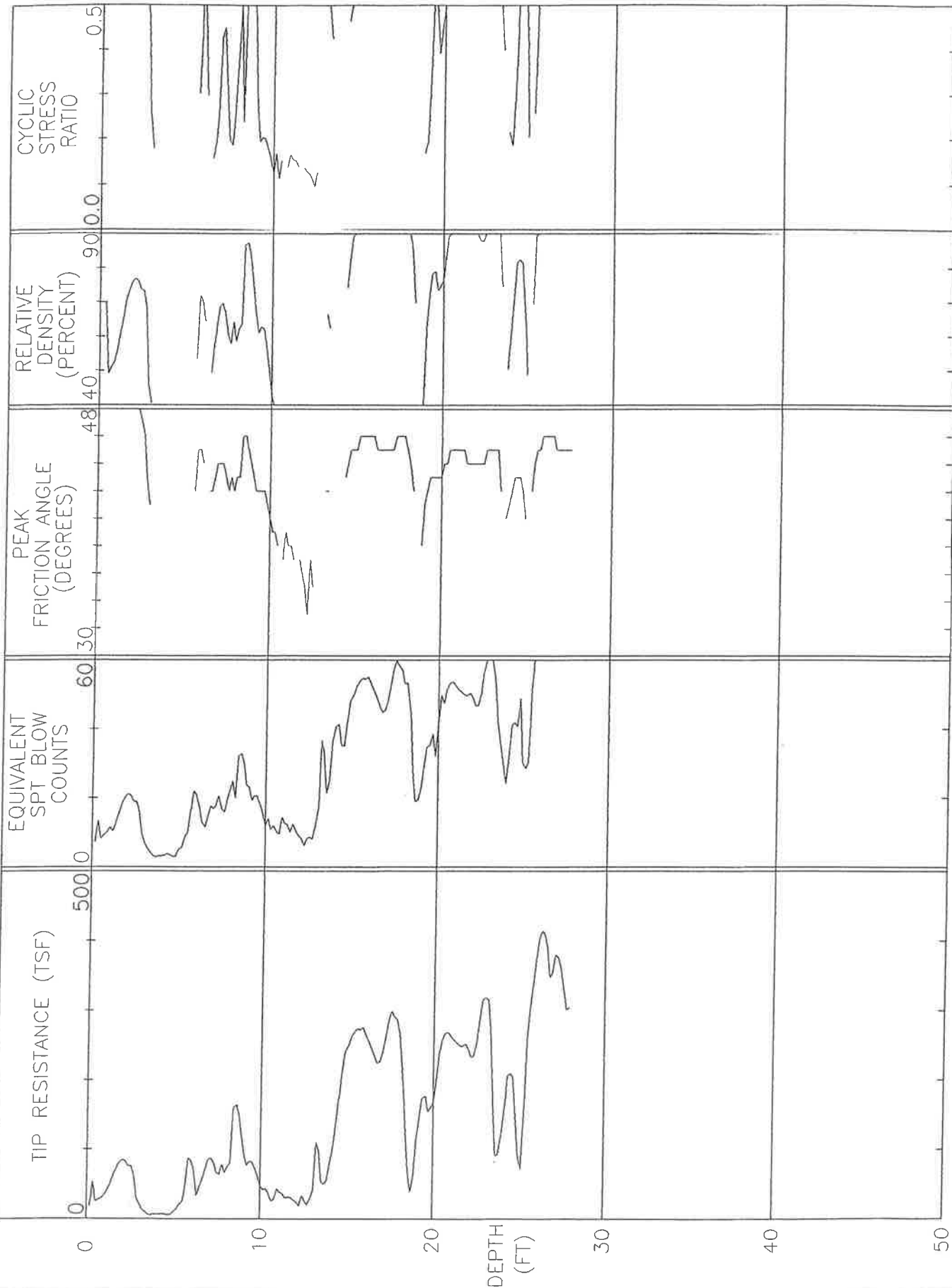
Location: CPT 7
 Job #: 41-2467-01
 Date: 12/19/94



Note: Peak friction angle, relative density, and cyclic stress ratio are undefined for cohesive soils. Cohesive data points are marked with 'C'.

Max Depth: 27.39 Feet

Location: CPT 8
 Job #: 41-2467-01
 Date: 12/20/94



Note: Peak friction angle, relative density, and cyclic stress ratio are undefined for cohesive soils. Cohesive data points are not plotted

Max Depth: 27.89 Feet



KLEINFELDER

PROJECT NO. 41-2467-01-001

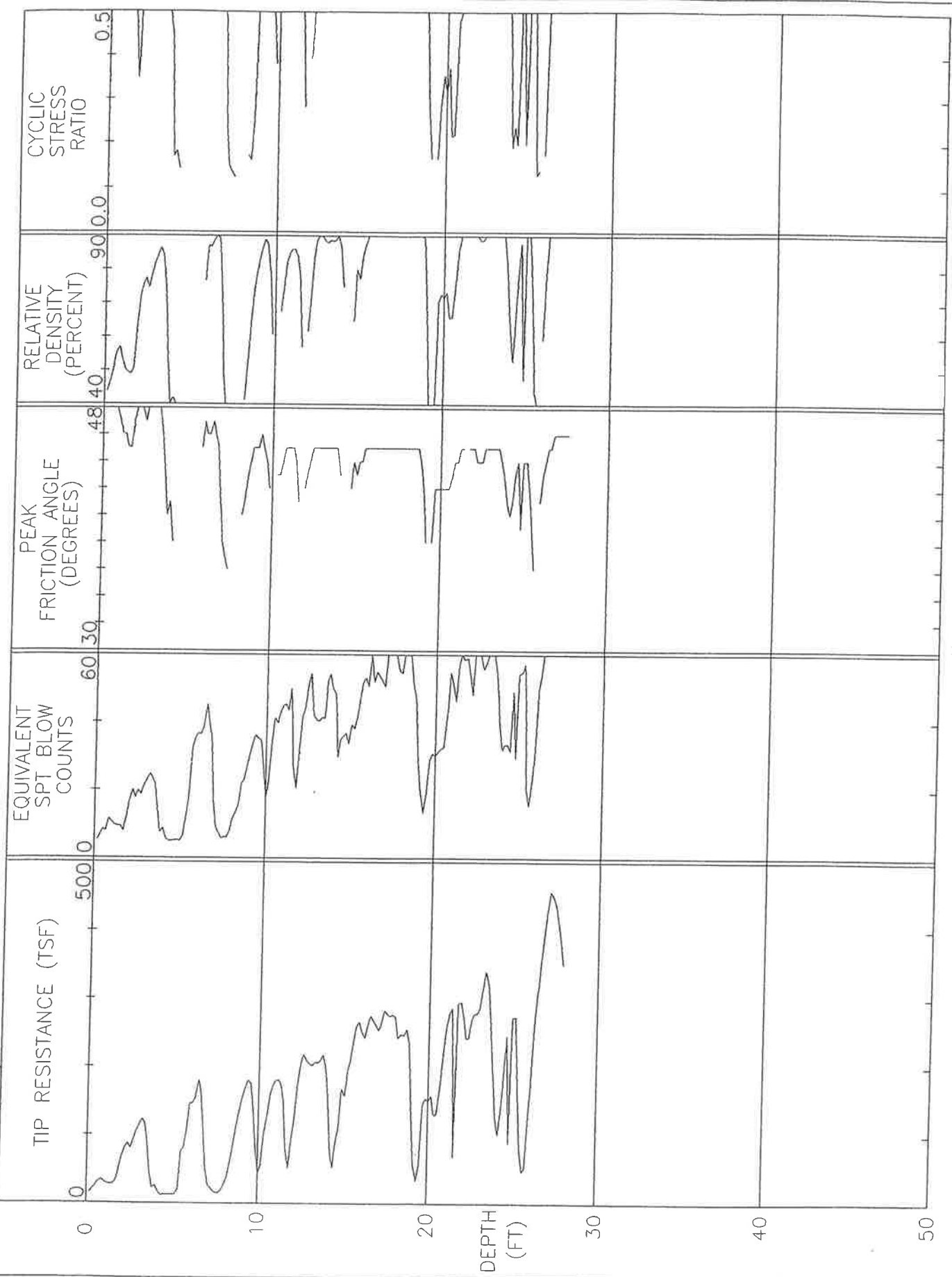
Job No: 41-2467-01
 Appr:
 Drwn: RNL
 Date: 12/22/94

LOG OF CPT 8
 HUMBOLDT COUNTY COURTHOUSE
 EUREKA, CA

PLATE

9

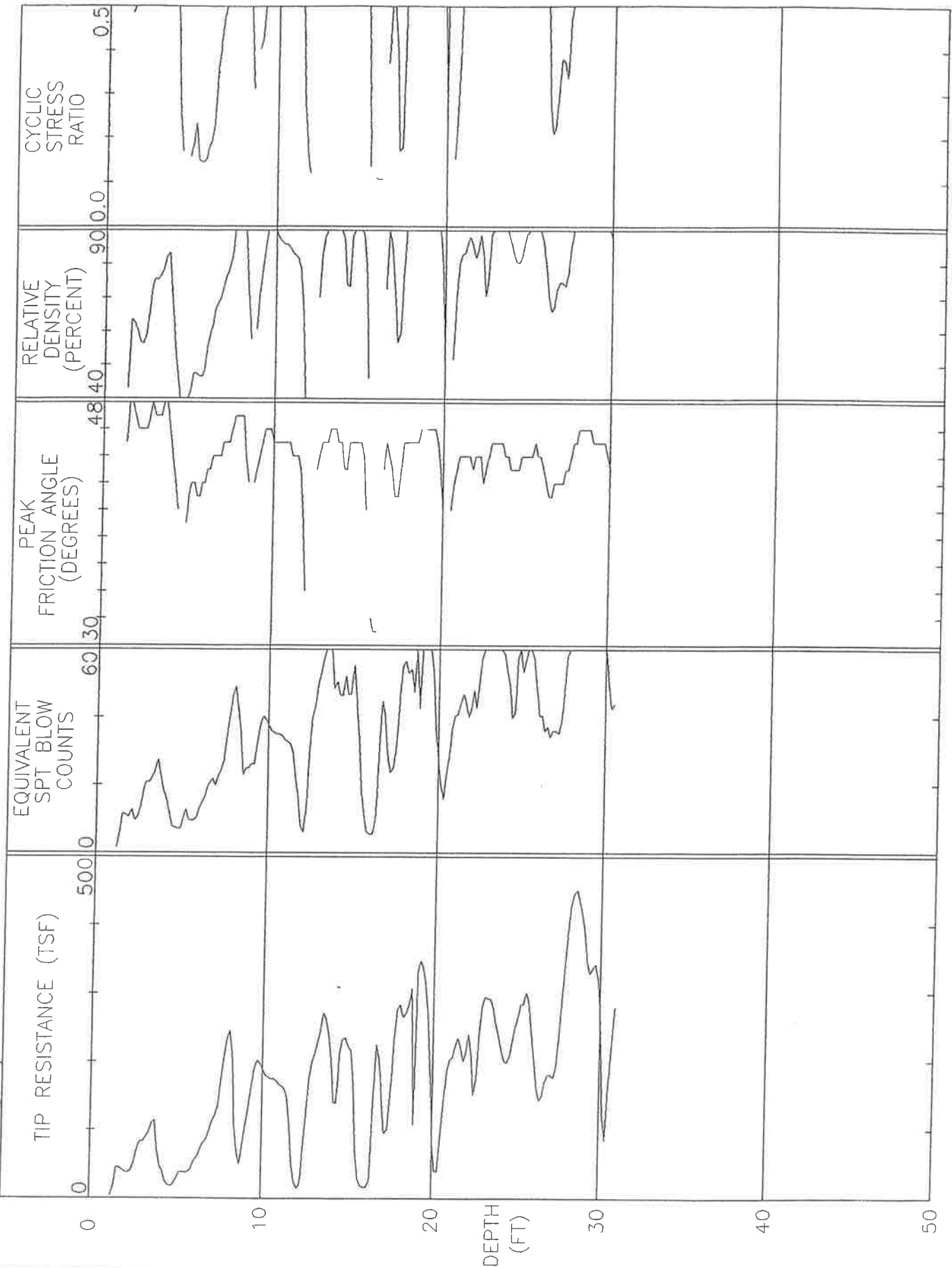
Location: CPT 9
 Job #: 41-2467-01
 Date: 12/20/94



Note: Peak friction angle, relative density, and cyclic stress ratio are undefined for observations with a cyclic stress ratio less than 0.1.

Max Depth: 27.89 Feet

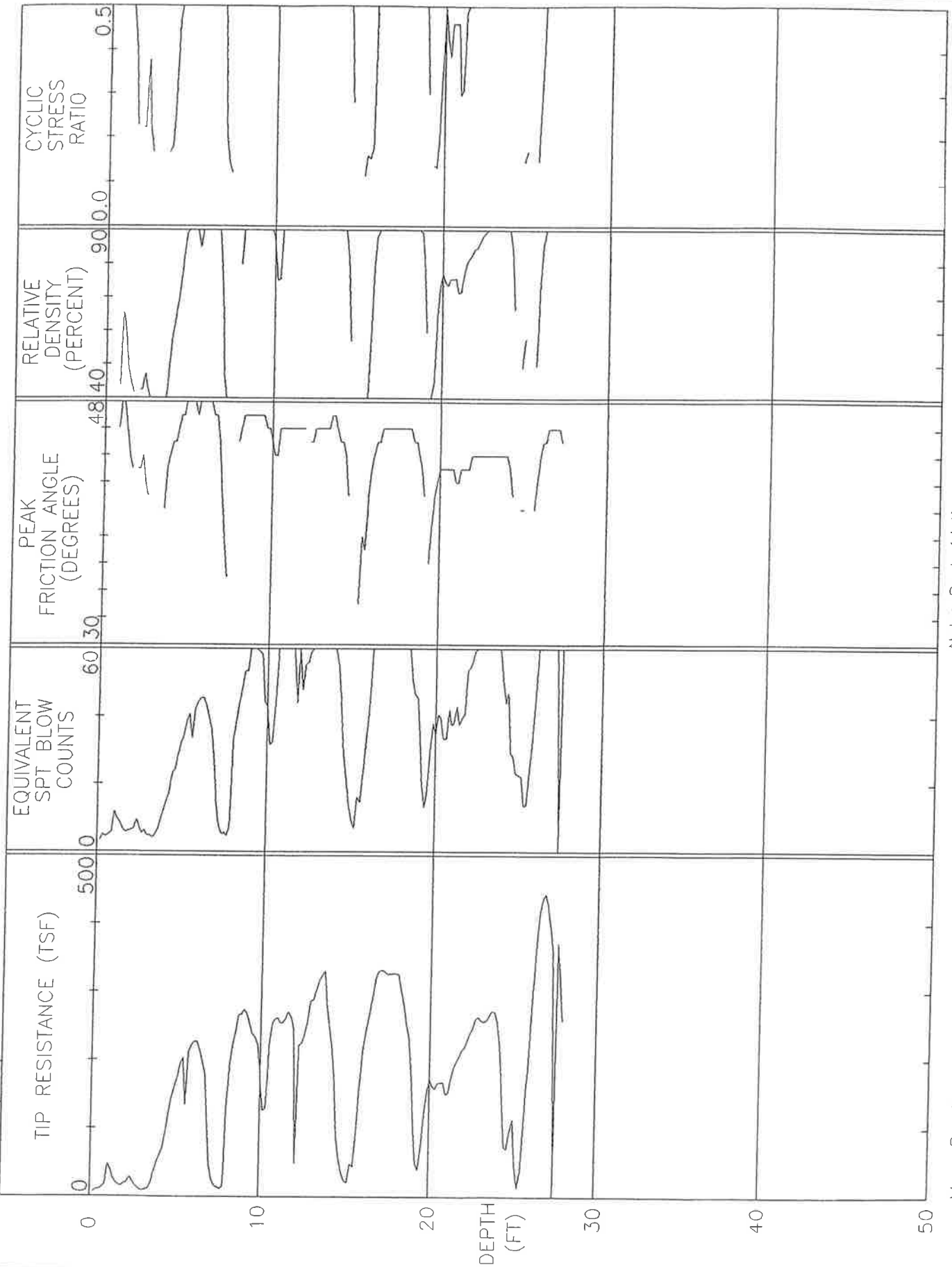
Location: CPT 10
 Job #: 41-2467-01
 Date: 12/20/94



Note: Peak friction angle, relative density, and cyclic stress ratio are undefined for depths greater than 30 feet.

Max Depth: 30.84 Feet

Location: CPT 11
 Job #: 41-2467-01
 Date: 12/21/94



Max Depth: 28.05 Feet

Note: Peak friction angle, relative density, and cyclic stress ratio are undefined for cohesive soils. Cohesive data points are not plotted.



KLEINFELDER

PROJECT NO. 41-2467-01-001

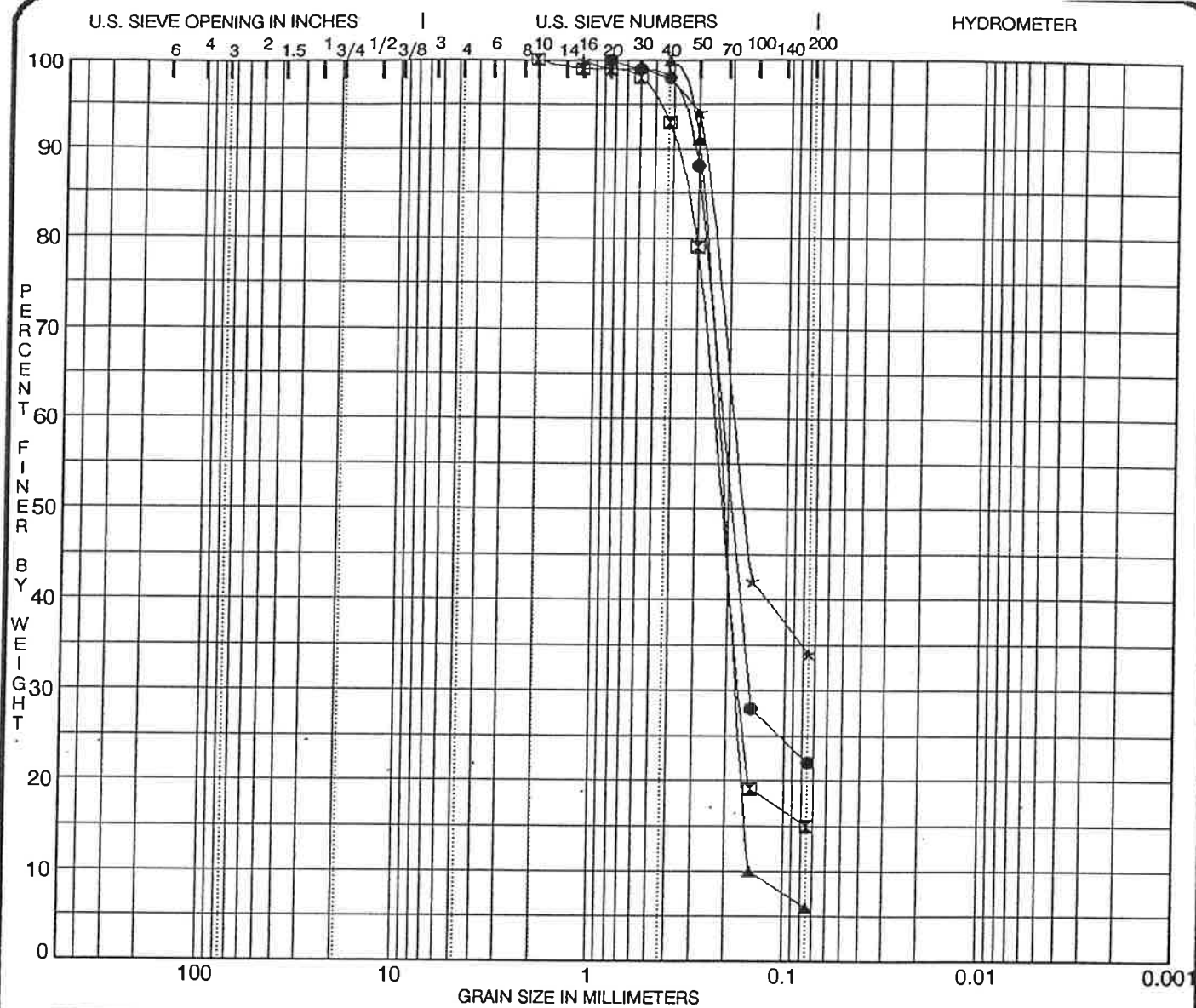
Job No: 41-2467-01
 Appr:
 Drwn: RNL
 Date: 12/22/94

LOG OF CPT 11

HUMBOLDT COUNTY COURTHOUSE
 EUREKA, CA

PLATE

12



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

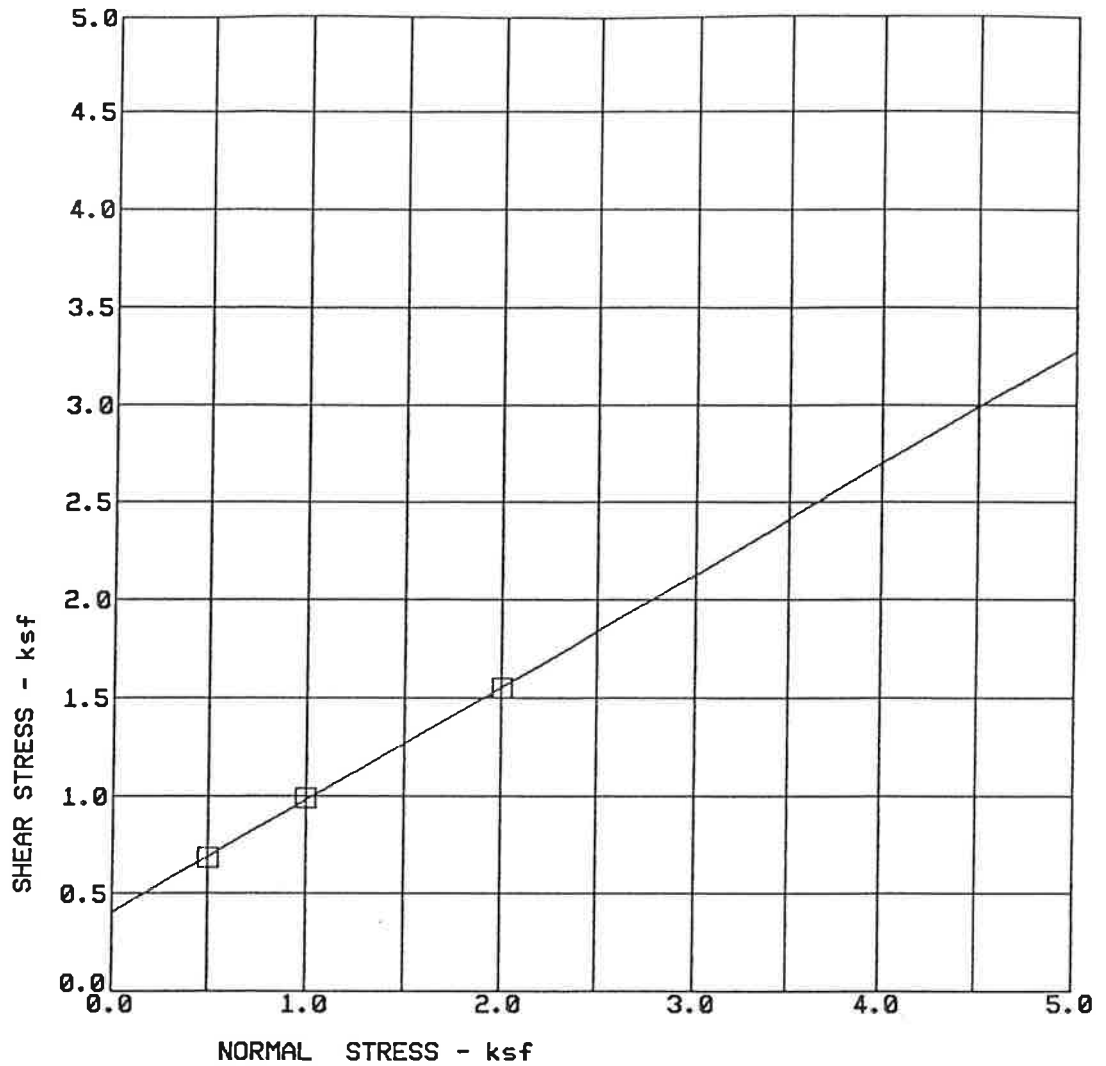
Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
● KB-5 3.0	silty fine grained sand (SM)						
□ KB-5 9.0	silty fine grained sand (SM)	22					
▲ KB-5 26.0	fine grained sand (SP)	21				0.92	1.5
★ KB-5 31.0	silty/clayey fine grained sand (SM-SC)	17					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● KB-5 3.0	0.85	0.22	0.15		0	78		22
□ KB-5 9.0	2.00	0.24	0.17		0	85		15
▲ KB-5 26.0	0.43	0.23	0.18	0.150	0	94		6
★ KB-5 31.0	1.18	0.19			0	66		34

PROJECT Humboldt County Courthouse JOB NO. 41-2467-01-001
Eureka, California DATE 12/20/94

GRADATION CURVES

Kleinfelder
 Santa Rosa, California



TEST TYPE: CD/WET/STAGED

RATE OF SHEAR: 0.0048 in/min

PIT NO: KB-5

DEPTH: 6.0 ft

SOIL DESCRIPTION: Mottled Yellow-Brown Silty Sand

DRY DENSITY - pcf	109		
INITIAL WATER CONTENT - %	18.7		
FINAL WATER CONTENT - %	19.6		
NORMAL STRESS - psf	500	1000	2000
MAXIMUM SHEAR - psf	681	985	1546

FRICITION ANGLE = 30 deg.

COHESION= 0.40 ksf



KLEINFELDER

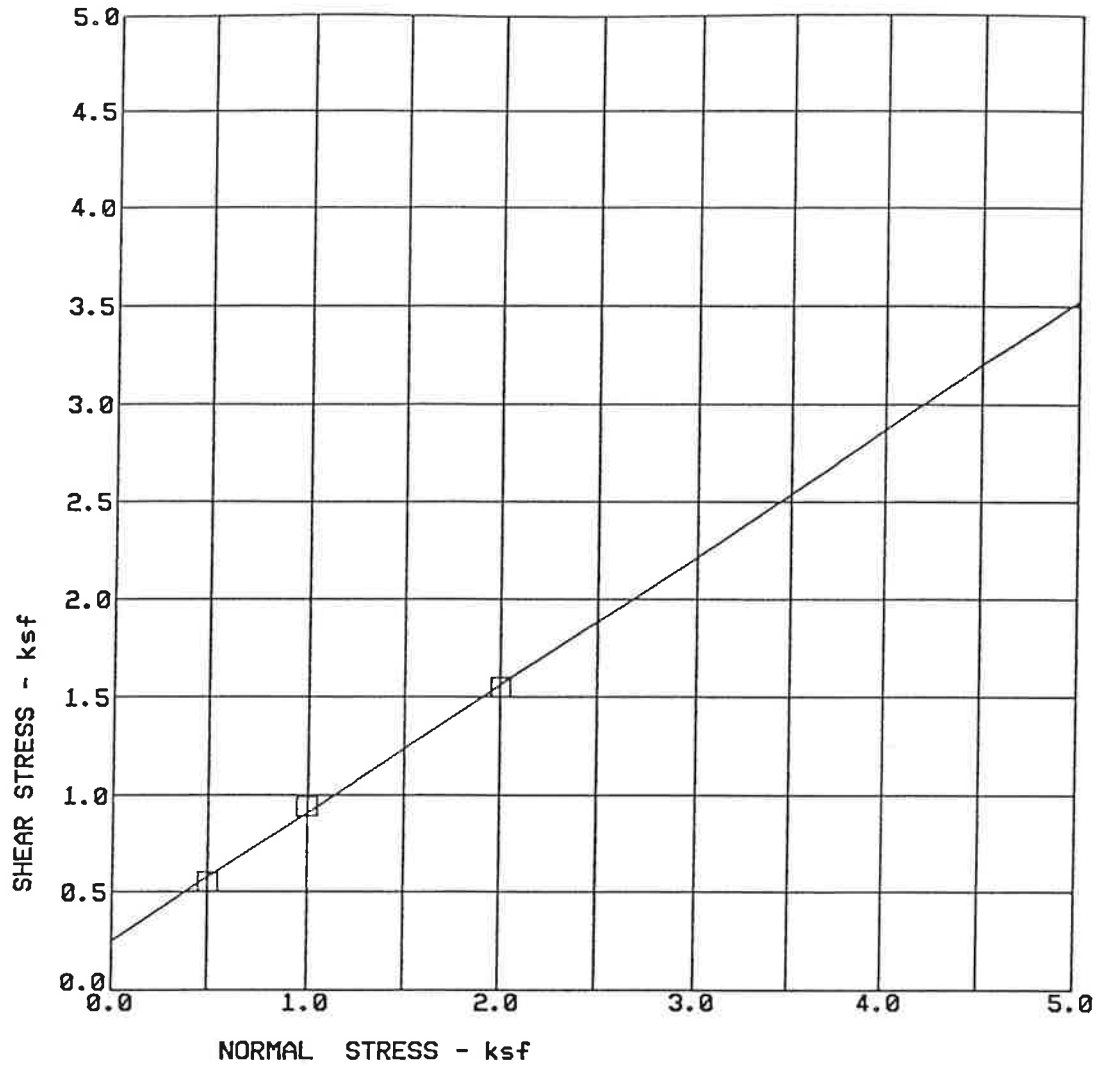
Humboldt County Courthouse
Eureka, California

DIRECT SHEAR TEST

PLATE

14

PROJECT NO. 41-2467-01-001



TEST TYPE: CD/WET/STAGED

RATE OF SHEAR: 0.0048 in/min

PIT NO: KB-5

DEPTH: 14.5 ft

SOIL DESCRIPTION: Orange-Brown Sand

DRY DENSITY - pcf	108		
INITIAL WATER CONTENT - %	18.9		
FINAL WATER CONTENT - %	21.5		
NORMAL STRESS - psf	500	1000	2000
MAXIMUM SHEAR - psf	550	943	1546

FRICITION ANGLE = 33 deg.

COHESION= 0.25 ksf

KH KLEINFELDER

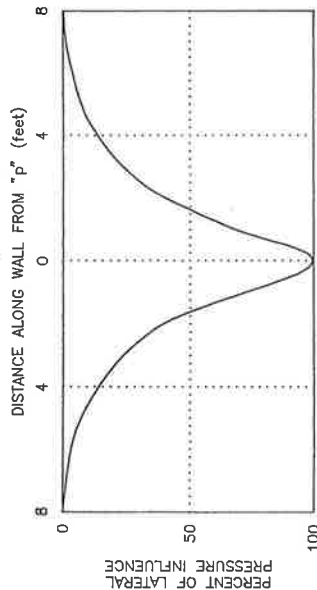
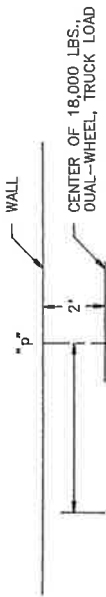
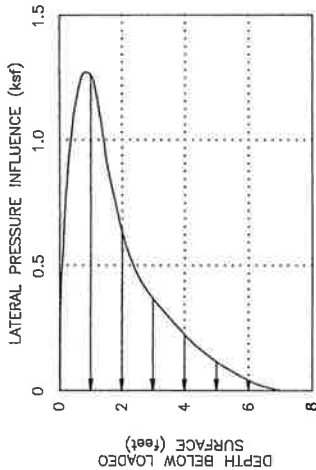
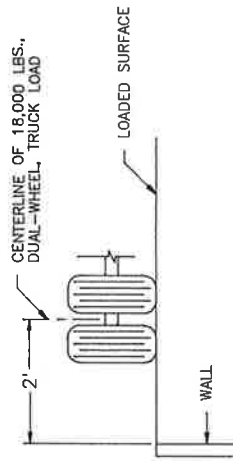
Humboldt County Courthouse
Eureka, California

PLATE

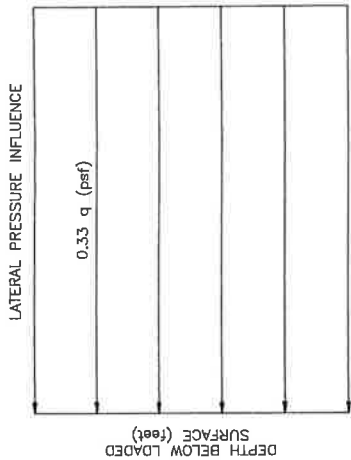
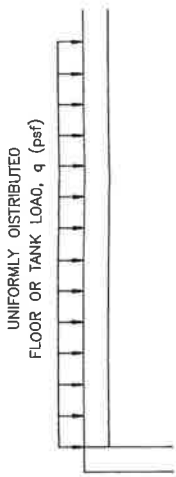
DIRECT SHEAR TEST

15

PROJECT NO. 41-2467-01-001



LATERAL PRESSURE INFLUENCE DIAGRAMS FOR DUAL-WHEEL TRUCK LOADS



LATERAL PRESSURE INFLUENCE DIAGRAM FOR UNIFORMLY DISTRIBUTED LOADS

NOTES:

1. Reference for Truck Load: Highway Research Board Bulletin 141.
2. Lateral influence pressures for other truck wheel loads located two feet behind a wall would be directly proportional to those shown for a 18,000 lbs., dual-wheel, truck load.
3. For uniformly distributed floor or tank loads located back away from retaining or subsurface walls, the lateral pressure influence will be less than shown. We can provide specific influence values for such cases, if requested.

BROCHURE

IMPORTANT INFORMATION ABOUT YOUR GEOTECHNICAL ENGINEERING REPORT

As the client of a consulting geotechnical engineer, you should know that site subsurface conditions cause more construction problems than any other factor. ASFE/The Association of Engineering Firms Practicing in the Geosciences offers the following suggestions and observations to help you manage your risks.

A GEOTECHNICAL ENGINEERING REPORT IS BASED ON A UNIQUE SET OF PROJECT-SPECIFIC FACTORS

Your geotechnical engineering report is based on a subsurface exploration plan designed to consider a unique set of project-specific factors. These factors typically include: the general nature of the structure involved, its size, and configuration; the location of the structure on the site; other improvements, such as access roads, parking lots, and underground utilities; and the additional risk created by scope-of-service limitations imposed by the client. To help avoid costly problems, ask your geotechnical engineer to evaluate how factors that change subsequent to the date of the report may affect the report's recommendations.

Unless your geotechnical engineer indicates otherwise, do not use your geotechnical engineering report:

- when the nature of the proposed structure is changed, for example, if an office building will be erected instead of a parking garage, or a refrigerated warehouse will be built instead of an unrefrigerated one;
- when the size, elevation, or configuration of the proposed structure is altered;
- when the location or orientation of the proposed structure is modified;
- when there is a change of ownership; or
- for application to an adjacent site.

Geotechnical engineers cannot accept responsibility for problems that may occur if they are not consulted after factors considered in their report's development have changed.

SUBSURFACE CONDITIONS CAN CHANGE

A geotechnical engineering report is based on conditions that existed at the time of subsurface exploration. Do not base construction decisions on a geotechnical engineering report whose adequacy may have been affected by time. Speak with your geotechnical consultant to learn if additional tests are advisable before construction starts. Note, too, that additional tests may be required when subsurface conditions are affected by construction operations at or adjacent to the site, or by natural events such as floods, earthquakes, or ground water fluctuations. Keep your geotechnical consultant apprised of any such events.

MOST GEOTECHNICAL FINDINGS ARE PROFESSIONAL JUDGMENTS

Site exploration identifies actual subsurface conditions only at those points where samples are taken. The data were extrapolated by your geotechnical engineer who then applied judgment to render an opinion about overall subsurface conditions. The actual interface between materials may be far more gradual or abrupt than your report indicates. Actual conditions in areas not sampled may differ from those predicted in your report. While nothing can be done to prevent such situations, you and your geotechnical engineer can work together to help minimize their impact. Retaining your geotechnical engineer to observe construction can be particularly beneficial in this respect.

A REPORT'S RECOMMENDATIONS CAN ONLY BE PRELIMINARY

The construction recommendations included in your geotechnical engineer's report are preliminary, because they must be based on the assumption that conditions revealed through selective exploratory sampling are indicative of actual conditions throughout a site. Because actual subsurface conditions can be discerned only during earthwork, you should retain your geotechnical engineer to observe actual conditions and to finalize recommendations. Only the geotechnical engineer who prepared the report is fully familiar with the background information needed to determine whether or not the report's recommendations are valid and whether or not the contractor is abiding by applicable recommendations. The geotechnical engineer who developed your report cannot assume responsibility or liability for the adequacy of the report's recommendations if another party is retained to observe construction.

GEOTECHNICAL SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES AND PERSONS

Consulting geotechnical engineers prepare reports to meet the specific needs of specific individuals. A report prepared for a civil engineer may not be adequate for a construction contractor or even another civil engineer. Unless indicated otherwise, your geotechnical engineer prepared your report expressly for you and expressly for purposes you indicated. No one other than you should apply this report for its intended purpose without first conferring with the geotechnical engineer. No party should apply this report for any purpose other than that originally contemplated without first conferring with the geotechnical engineer.

GEOENVIRONMENTAL CONCERNS ARE NOT AT ISSUE

Your geotechnical engineering report is not likely to relate any findings, conclusions, or recommendations

about the potential for hazardous materials existing at the site. The equipment, techniques, and personnel used to perform a geoenvironmental exploration differ substantially from those applied in geotechnical engineering. Contamination can create major risks. If you have no information about the potential for your site being contaminated, you are advised to speak with your geotechnical consultant for information relating to geoenvironmental issues.

A GEOTECHNICAL ENGINEERING REPORT IS SUBJECT TO MISINTERPRETATION

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a geotechnical engineering report. To help avoid misinterpretations, retain your geotechnical engineer to work with other project design professionals who are affected by the geotechnical report. Have your geotechnical engineer explain report implications to design professionals affected by them, and then review those design professionals' plans and specifications to see how they have incorporated geotechnical factors. Although certain other design professionals may be familiar with geotechnical concerns, none knows as much about them as a competent geotechnical engineer.

BORING LOGS SHOULD NOT BE SEPARATED FROM THE REPORT

Geotechnical engineers develop final boring logs based upon their interpretation of the field logs (assembled by site personnel) and laboratory evaluation of field samples. Geotechnical engineers customarily include only final boring logs in their reports. Final boring logs should not under any circumstances be redrawn for inclusion in architectural or other design drawings, because drafters may commit errors or omissions in the transfer process. Although photographic reproduction eliminates this problem, it does nothing to minimize the possibility of contractors misinterpreting the logs during bid preparation. When this occurs, delays, disputes, and unanticipated costs are the all-too-frequent result.

To minimize the likelihood of boring log misinterpretation, give contractors ready access to the complete geotechnical engineering report prepared or authorized for their use. (If access is provided only to the report prepared for you, you should advise contractors of the report's limitations, assuming that a contractor was not one of the specific persons for whom the report was prepared and that developing construction cost esti-

mates was not one of the specific purposes for which it was prepared. In other words, while a contractor may gain important knowledge from a report prepared for another party, the contractor would be well-advised to discuss the report with your geotechnical engineer and to perform the additional or alternative work that the contractor believes may be needed to obtain the data specifically appropriate for construction cost estimating purposes.) Some clients believe that it is unwise or unnecessary to give contractors access to their geotechnical engineering reports because they hold the mistaken impression that simply disclaiming responsibility for the accuracy of subsurface information always insulates them from attendant liability. Providing the best available information to contractors helps prevent costly construction problems. It also helps reduce the adversarial attitudes that can aggravate problems to disproportionate scale.

READ RESPONSIBILITY CLAUSES CLOSELY

Because geotechnical engineering is based extensively on judgment and opinion, it is far less exact than other design disciplines. This situation has resulted in wholly unwarranted claims being lodged against geotechnical engineers. To help prevent this problem, geotechnical engineers have developed a number of clauses for use in their contracts, reports, and other documents. Responsibility clauses are not exculpatory clauses designed to transfer geotechnical engineers' liabilities to other parties. Instead, they are definitive clauses that identify where geotechnical engineers' responsibilities begin and end. Their use helps all parties involved recognize their individual responsibilities and take appropriate action. Some of these definitive clauses are likely to appear in your geotechnical engineering report. Read them closely. Your geotechnical engineer will be pleased to give full and frank answers to any questions.

RELY ON THE GEOTECHNICAL ENGINEER FOR ADDITIONAL ASSISTANCE

Most ASFE-member consulting geotechnical engineering firms are familiar with a variety of techniques and approaches that can be used to help reduce risks for all parties to a construction project, from design through construction. Speak with your geotechnical engineer not only about geotechnical issues, but others as well, to learn about approaches that may be of genuine benefit. You may also wish to obtain certain ASFE publications. Contact a member of ASFE or ASFE for a complimentary directory of ASFE publications.

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